POPULAR SCIENCE

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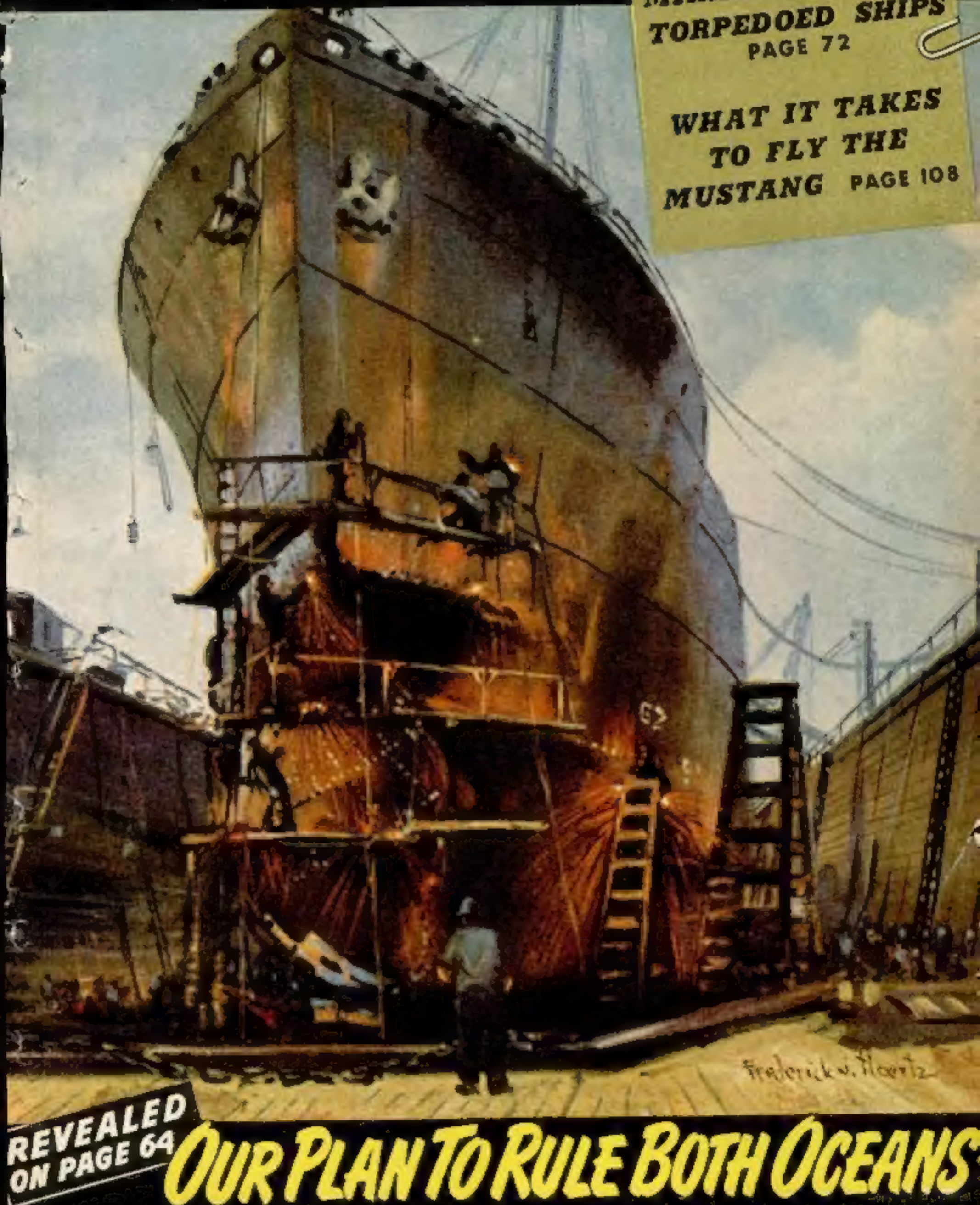
WHAT IT TAKES TO FLY THE MUSTANG PAGE 108



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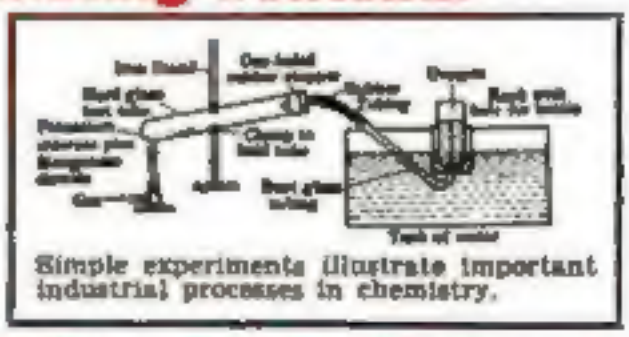

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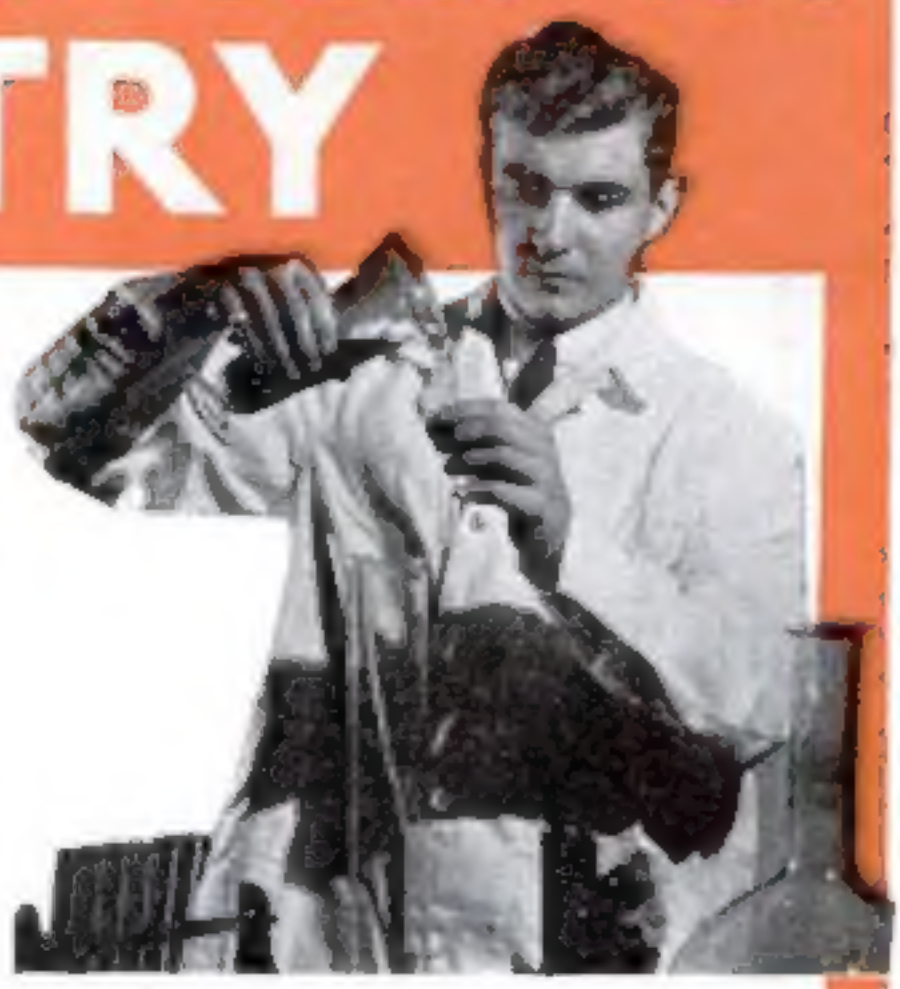

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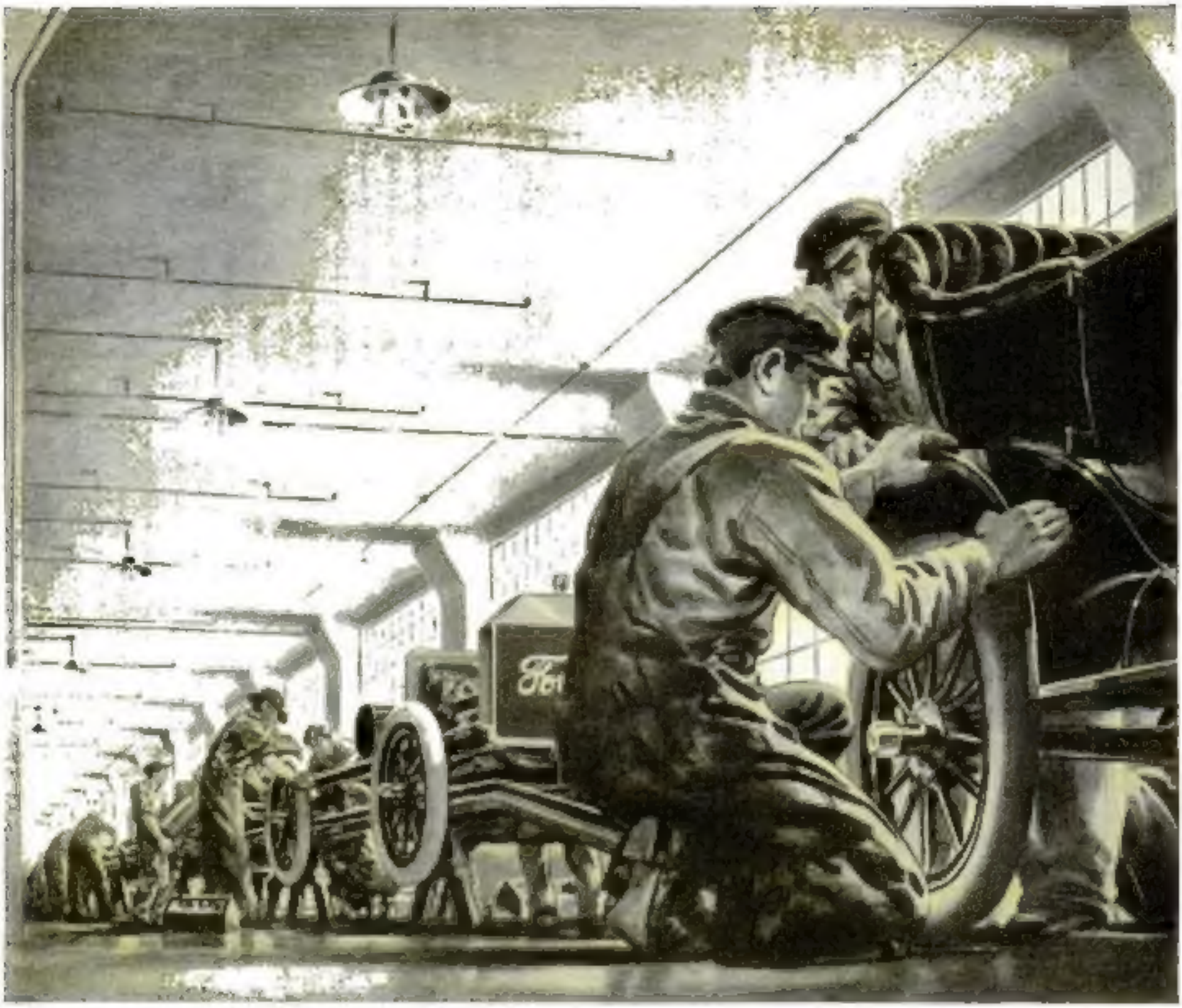


There and then . . . the assembly line was born

EARLY in 1913, Henry Ford had his technicians try a new production idea which had come to him as he inspected a watch factory. Instead of having a single group of men make the entire assembly on each flywheel magneto, the unit was moved from one worker to another. The result was a 50% saving in time!

"Why not test this idea on the whole chassis?" Mr. Ford next suggested. So now, along elevated greased rails, each chassis was being pushed by hand as workers added the various parts in sequence. *There and then, the assembly line was born!*

A chain-driven line was soon operating. And the 14 hours once required for a chassis assembly were cut to 1 hour, 33 minutes.

Before 1913 ended, over 100,000 Ford cars had been built, breaking all records for the industry.

This achievement meant more than a saving in time, more than creating new methods for all industry. To Mr. Ford and his associates, this was another step to make life easier for millions.

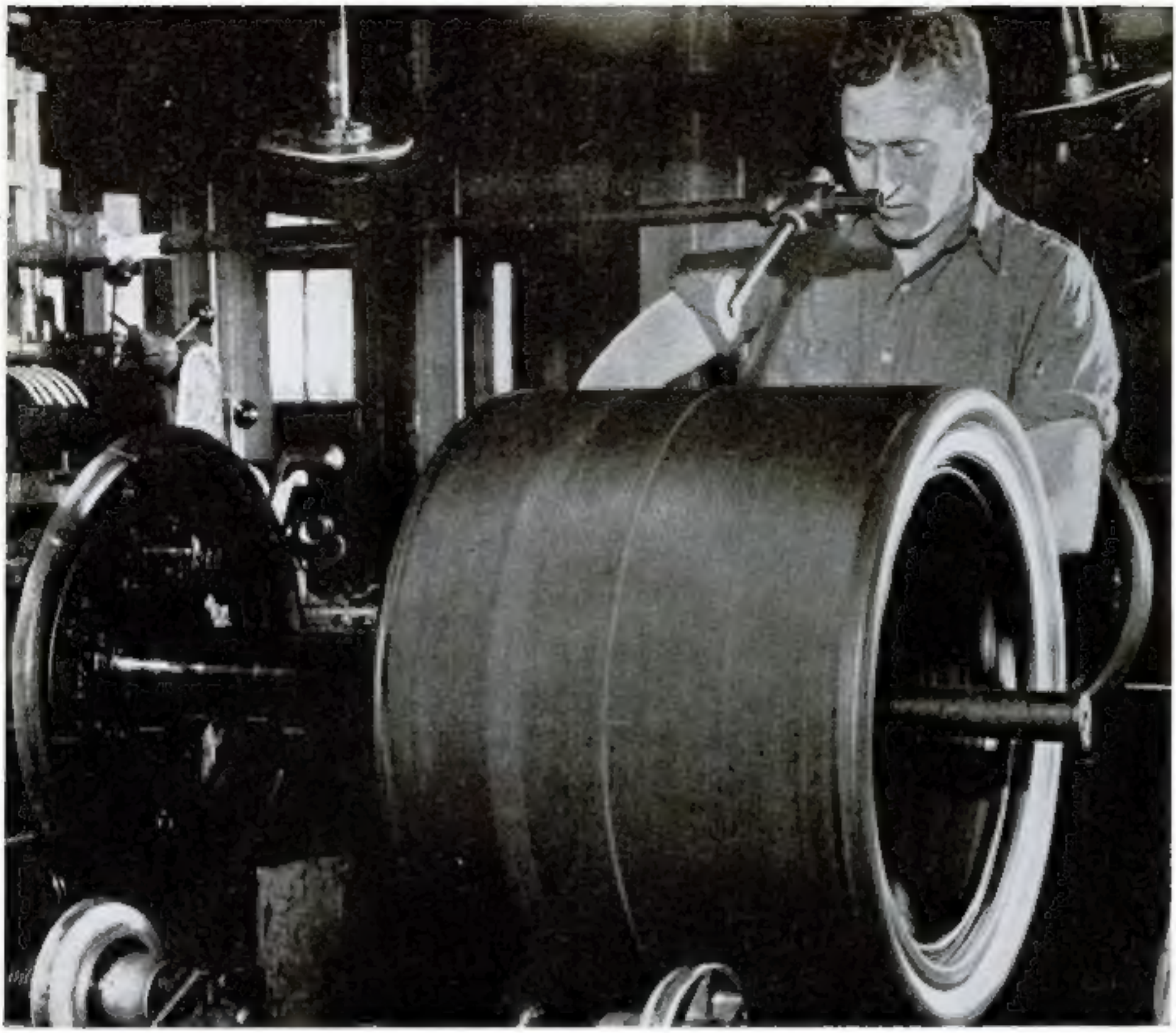
From the first, the assembly line technique of production eased working conditions. Along with other modern advances, it helped to increase the life span of workers. At Ford, it soon made possible the 8-hour day. And with unskilled labor in many places earning as little as $1 a day, Ford basic pay was raised to $5.

The assembly line also brought price reductions on Ford cars, placing them within reach of more people. Sharing production savings with the public is fundamental with Ford.

Today, in the creation of equipment vital to victory, Ford men continue their search for better ways of doing things. What they are learning is bound to be reflected in the improved Ford transportation of tomorrow.

FORD MOTOR COMPANY

Popular Science Monthly for August, 1944, Volume 145, Number 2. Published monthly at 353 Fourth Avenue, New York 10, N. Y., by Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 20, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Yearly subscriptions to the United States, $2.00.



The tack we put in every tire

Synthetic rubber used to rub itself the wrong way, until the chemists found the answer

A TIRE IS BUILT like a layer cake. First, one layer of rubber-coated cord, then another on top of it. The picture above shows a man building up the layers. That's an actual tire he's working on, *before* it's shaped and molded.

If the layers didn't stick together tight, the tire-builder would have a bad time of it. Production would slow down. Tire failures would increase.

Natural rubber has plenty of adhesiveness, or "tack." Synthetic rubber hasn't. So B. F. Goodrich engineers began to search for something that would give synthetic rubber more "tack."

The answer was found in a cement made from natural rubber. It is applied to both sides of each layer and the underside of the tread.

But this *natural* rubber (2% or less) in the new synthetic Silvertowns insures against lagging production, frequent failure.

By making and selling thousands of tires made with more than 50% synthetic long before the war, B. F. Goodrich engineers were able to get a three-year head start in compounding synthetic rubber—knowledge that today is invaluable to American car owners.

These tires totaled more than 80,000,000 miles. They were the first containing any synthetic rubber ever sold to American car owners. Many are still in use. Today's B. F. Goodrich tires for passenger cars are all-synthetic (98%) and are almost as good as pre-war tires. Truck tires aren't as good, especially in intercity service with overloads, but are improving daily.

Few can buy right now, but if you're one of those who *can* buy tires today, go to a B. F. Goodrich dealer or Silvertown store. You'll get tires backed by years of experience with synthetic rubber in all kinds of products—tires backed by this 80,000,000-mile road test. *The B. F. Goodrich Company, Akron, O.*

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FOUNDED 1872 MONTHLY VOL. 145 NO. 2

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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(Original for Todd Shipyards Corp.)

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LETTING THE CALENDAR CATCH UP

TO BRING the date when POPULAR SCIENCE MONTHLY goes on sale closer to the date on the cover of the magazine, we have effected this summer an adjustment of our time of publication. As a result, the September issue will appear on August 30, and thereafter each issue will be published on or about the first of the month that is shown on the cover.

Subscribers do not lose by this change, as each will receive the full number of issues to which he is entitled.

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This man moves mountains

MANUFACTURING machinery that enables tractors to move mountains is Robert G. LeTourneau's business. In 86 countries, his scrapers, bulldozers, Tournapulls, rooters are slicing high hills, throwing up dams, leveling fields. On every battle front of the United Nations, his earth-moving equipment is helping clear the way for advancing troops.

As a business man, Mr. LeTourneau last year recorded sales of some $40,000,000. As an inventor, he has more patents to his name than any other man in his field. As a Christian layman, he devotes 90 per cent of his business profits to Gospel work . . . operates one of the nation's largest religious foundations.

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R. G. LeTourneau

President

Mr. LeTourneau was a scraper repair man with an open lot "factory," when he first "took stock" of himself. Assets: Faith, energy, belief in hard work. Handicaps: Limited education, limited mechanical know-how.

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TURN PAGE FOR COUPON

Coming Next Month

ANTIAIRCRAFT GUNS, pitifully ineffective in World War I, have come a long way. In a recent Pacific action, U.S. ack-acks knocked down 25 Jap bombers out of a flight of 25. The story of these guns, and of the "predictors" that give them their amazing accuracy, will be told in an article on our 90 and 120-mm. guns that now reach all the way up into the stratosphere for enemy planes.

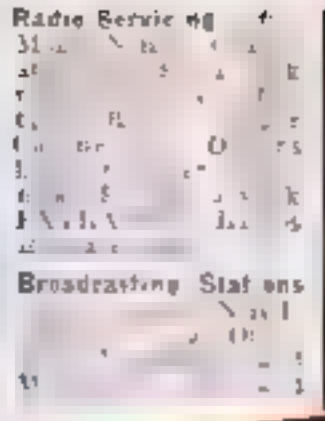
PUSHING 45,000 TONS—the weight of a giant battleship—through the water at 32 knots calls for engines a million times bigger than a watch, yet made with equal accuracy. And it's mighty interesting to see them work. So come along on next month's engine-room inspection tour and see some of the late developments that have made our sea fighters the best-powered ships afloat.

PRECIOUS JUNK. Mario Ammaribile, antique-shop owner, has New York socialites beating a path to his door for the unusual furniture he has created from parts of razed mansions. In this article, he shows how, with a little labor-saving ingenuity, such junked pieces as moldings, banisters, and mantelpieces can be made into exquisite tables, screens, lamps, and similar furnishings. Here are professional tips no home owner will want to miss.

MEET SKIPPER KROLL and his 336-ton tug. Together they've traveled over 75,000 nautical miles since Pearl Harbor, towing barges laden with war materials from one harbor to another, hauling crippled ships back into port, and saving shipwrecked sailors while side-stepping enemy torpedoes. Here's a thrill-packed yarn of the sea, and of an old-time harbor skipper (now in the Pacific) who refused to stay home when the going got tough.

SHOOTING WATER is a favorite sport with many a photo fan who snaps his shutter whenever he comes to a stream or pond, river or ocean. Often, though, results don't come up to expectation. Next month we'll offer some practical pointers on taking water scenes, written by a photographer whose prints have won salon prizes. You'll find good tips on viewpoint, shutter speed, and exposure.

ELECTRONICS. In the third of a series of four articles, Carl Dreher tells of the seemingly impossible jobs electronics is doing—this time in the field of industry. Citing their invaluable uses in such work as resistance welding, induction heating, and stroboscopic counting, Mr. Dreher shows how electronic tubes have made possible amazingly accurate methods of measurement and control.



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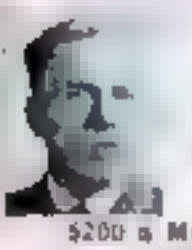

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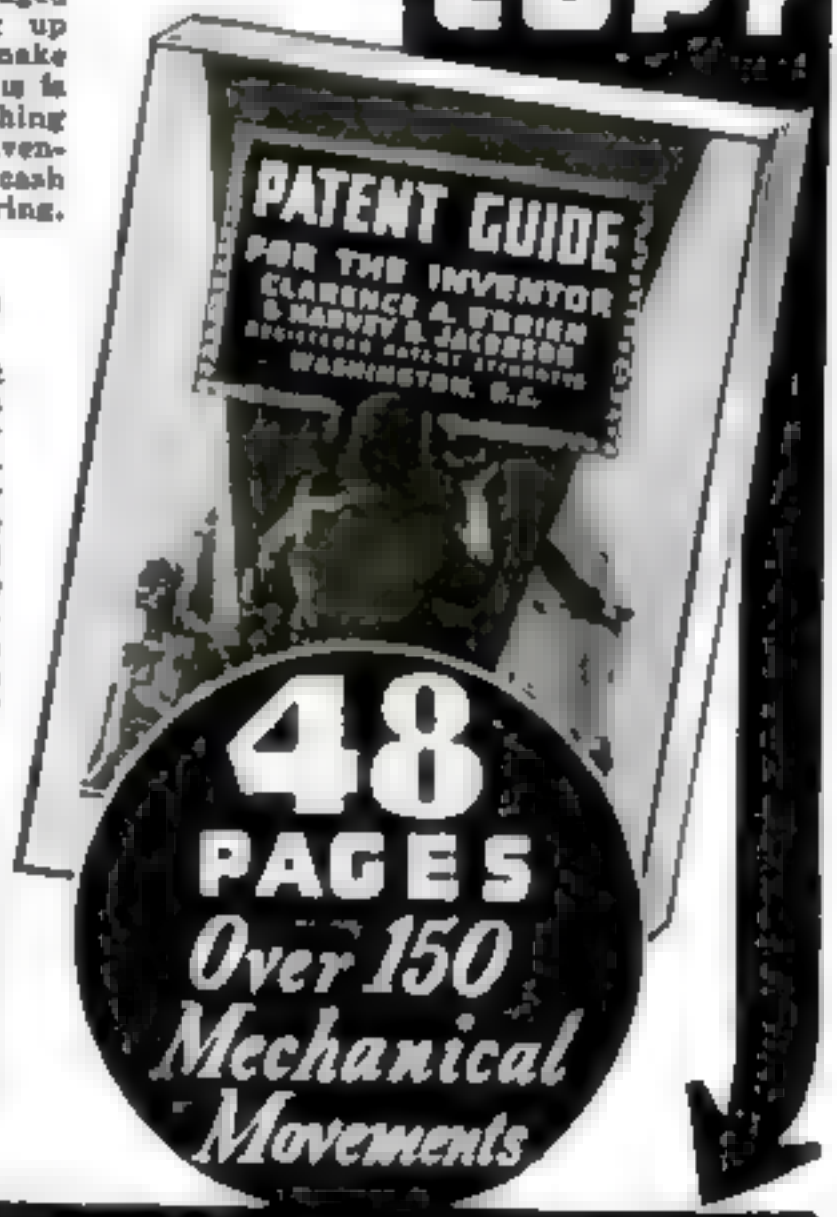

Patent Guide Shows What To Do

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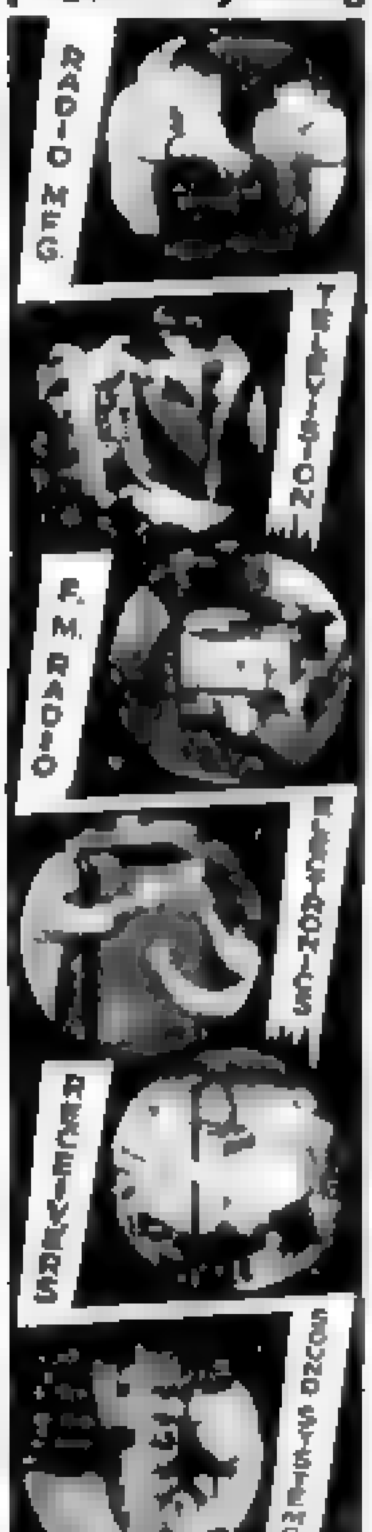

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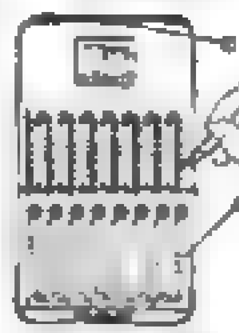

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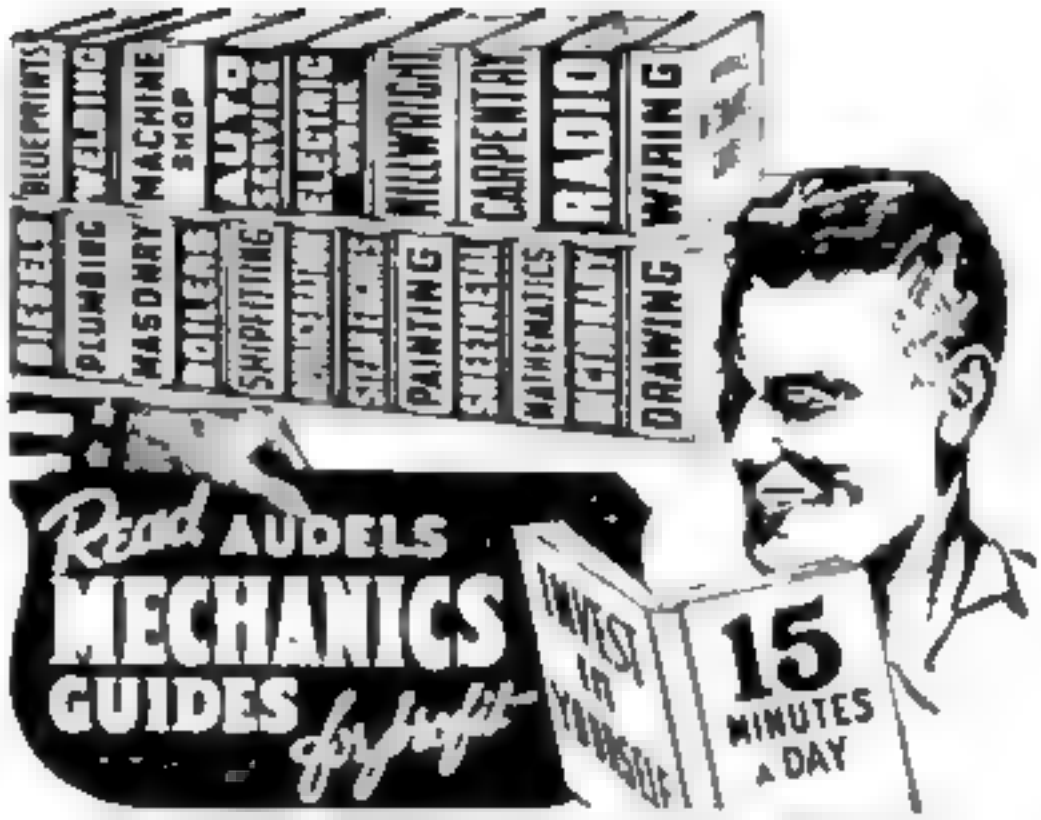

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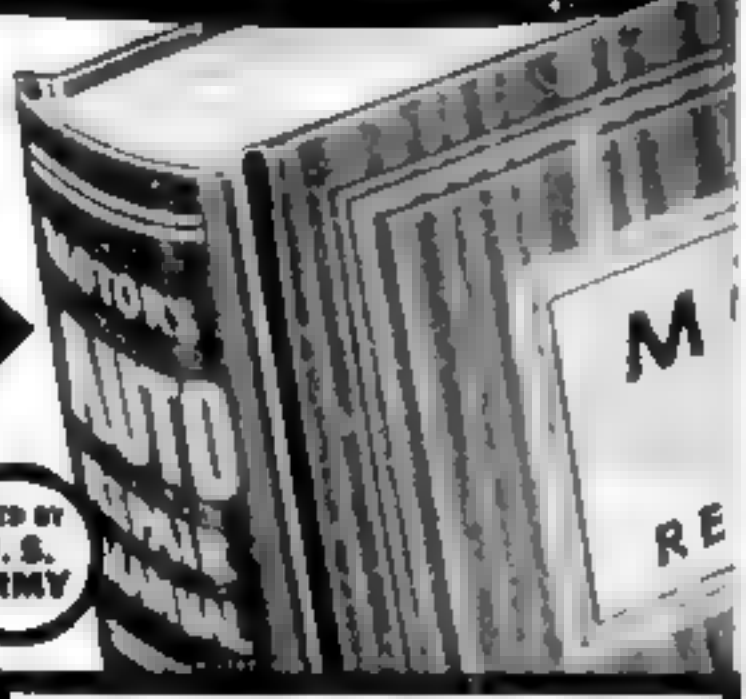

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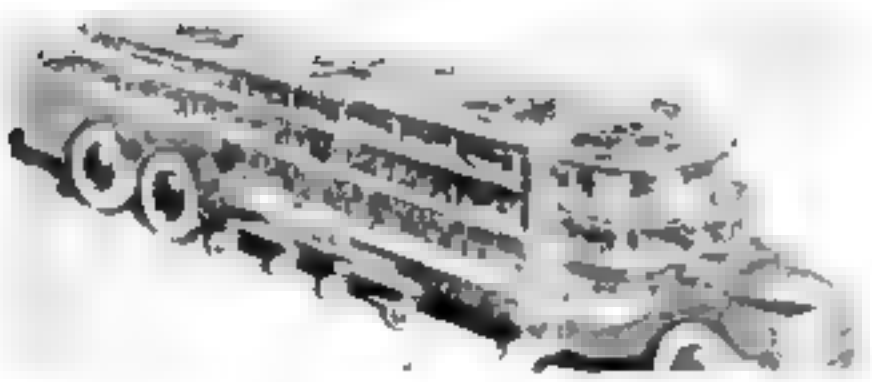

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I WAS interested in comparing the picture of the super-duper 600-passenger bus in your June issue with a similar picture that was put out 19 years ago by Mack Trucks, Inc. I enclose a copy and I hope you can publish it. The title was "The Bus Salesman's Dream of 1950." I have no doubt that in 1975 this artist's conception of the very supest-dupest luxury liner of the highways will look as old fashioned as a 1910 Ford does now. Does anybody wanna bet?—A. McT., Boise, Idaho.

Perhaps This Man Is Headed for Fame

IN YOUR February issue an article by Kenneth M. Swezey on catalysts concludes with: "Fame awaits whoever solves the mystery of why catalysts produce their results." Or do they get the razzberry? This is my theory: All atoms are composed of a number of particles of matter revolving around a nucleus of higher frequency like a planetary system. All of these particles are polarized just as are the planets, and compounds of matter unite them when the poles of their atomic particles are not opposed, but will not unite when opposed. Much matter can adjust its polarity to accommodate a union with other matter, or it can compel other matter to change its polarity. What happens is that some of the particles of which the matter is composed swing slightly on their axes until their poles synchronize with those it strives to unite with. A catalyst is a third agent which has the power of affecting one or the other of two molecules whose poles are opposed magnetically by changing the polarity to an extent that a union can be formed by the change of polarity thus caused.—W. C. B., Calgary, Alberta, Canada.

Here's a Chance for the Home Chemists

IT HAS been with considerable interest that I have read your articles about Dr. Ehrenhaft's experiments with what he calls magnetic currents. It seems to me that his method, although impressive, could perhaps be simplified, and as I have no laboratory equipment at my disposal, I wonder if someone is interested enough to try the method herein outlined. First, by taking a permanent magnet and placing on each of the poles a piece of pure iron fastened with cement, and the whole assembly dipped in an acid-proof paint (Insulex-black) with the exception of the ends of the iron poles. Then immerse the entire magnet in the acid solution and place the test tubes, inverted, over the poles. As glass is no insulator for magnetism, if the professor's findings are true, then the above-outlined method should yield the same results. A comparison check of the relative strength of the two magnets may be easily obtained. However, as a permanent magnet loses rapidly by removing a keeper and replacing it, two magnets should be used, each weighed once before the electrolysis test and once after, so that the percentage of difference could be computed without difficulty.—E. R. L., Harrisburg, Pa.

We see no reason why this simplified version of Dr. Ehrenhaft's experiment shouldn't work, provided: (1) care is taken to obtain good metal-to-metal contact in fastening the pole pieces to the magnet; and (2) everything but the ends of the pole pieces is completely insulated from the solution in order to avoid stray electric currents that might be set up by the dissimilar metals of the magnet alloy.—Ed.

Maybe a Tame Spitting Cobra Would Solve the Problem

IN REPLY to J. O. Y.'s June letter asking for a chemical you could shoot at an attacker's eyes, well, here's one that would be harmless but temporarily effective. Simply use grapefruit juice.—D. L. A., Baltimore, Md

HERE is the perfect solution for J. O. Y.'s squirt gun to repel an attacker. A mixture of ⅓ soap and ⅔ water will meet the desired specifications.—R. C. B., Mansfield, Ohio.

Flight Plan for New Frontiers

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Readers Say:

Aged Loudspeaker Lives to Speak Another Day

THROUGH Popular Science I renewed an idea that I have tried to put across to a radio repair man in the neighborhood. When I had to discard my antiquated radio, there was a magnetic loudspeaker left that was perfectly good. So I put it away for possible future use. Now my daughter has a record-playing attachment that she has used on her little table-model radio. It works well, but the volume on some of her better records is too big for the small speaker, so that she has to use cactus needles. My idea was to have the magnetic speaker attached. One man I spoke to about it said it couldn't be done. Now I have found an article in Pop. Sci. telling how it *could* be done, and I'm going to make that fellow do it.—A. A. A., San Francisco, Calif.

Okay, Son, Look for the Ship Pin-Up in September

I READ your magazine from cover to cover and I like it very much. My dad is in the Navy; I send him some of your stories, and he says he likes them very much too. I hope some day to be able to go to Annapolis and then make my living from the Navy. It seems that you have a very good book because I get A's from reports that I take from your magazine. I am sure glad that I get your magazine, and so is my dad. Why don't you have pin-up pictures of boats too? I mean like PT boats.—J. B., Detroit, Mich.

Letters like yours make us try even harder to get things right. We'd hate like the Old Harry to be the cause of your getting anything less than A's in your school work. Hope you succeed in making Annapolis.—Ed.

What Do You Mean "Even Editors"?

CAN any of your readers, or even editors, tell me authoritatively which came first, the lever or the fulcrum?—S. Van D. P., Dover, Del.

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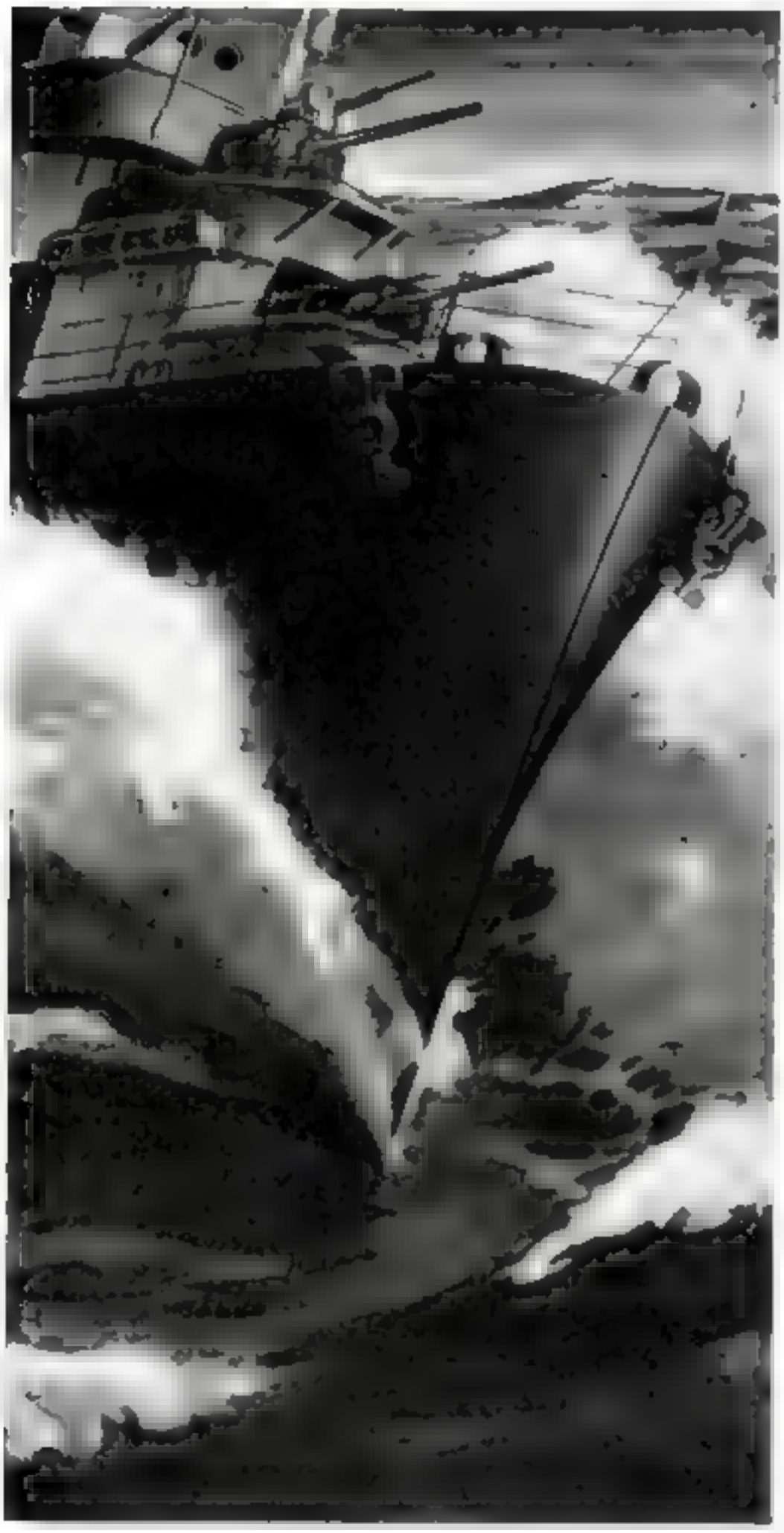

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Readers Say:

Publishers' Persuasion Results in Two-way Benefit

MY SON was a subscriber to P.S.M. Then he got in the Army and his subscription expired. I let you implore me time after time to renew, and finally I did, and in the first issue I got, what do you think I found? The article about gliders and glider troops, and the article "1001 Uses for Jeeps." I am a rural mail carrier and need a mud car. I have a 48-mile trip, 16 miles of it on old Mother Earth. I now use a 1926 (yes, 1926) Chevrolet shortened 20 inches, with the fenders and running boards raised high; but it is getting hard to obtain old or new repair parts, so I hope to be able to get a jeep. I have used two such Chevvies, and they are very efficient, but there are times when one needs a saddle horse. I am sure glad I got those articles.—V. M. F., Hale, Mo.

Wants to Build His Own Jet-Propelled Plane

So you are running an article on the jet-propulsion plane. It is supposed to be great stuff. I refuse, though, to believe that it has really arrived until you or one of your rivals runs a series of articles on how to build one in your garage. As soon as the secrecy is off the jet plane, how about such a series? I know where I can get hold of a torch, and now if you can do your part, we'll be all set. —E. S., Wichita, Kans.

We showed your letter to the Aviation Editor, and he said, "Well, I've seen the thing fly twice, and I still don't believe it." —Ed.

This Shows that P.S.M. Is Read With a Fine-Tooth Comb

IN your May issue of Popular Science we found a slight mistake on the cover. You stated that the machine guns in the flexible mount were .50 caliber. We wish to inform you that they are .30 caliber.—B. G. and B. G., Naval Air Technical Training Center, Norman, Okla.

Thank you and other readers who have written about this. Our ears are red.—Ed.

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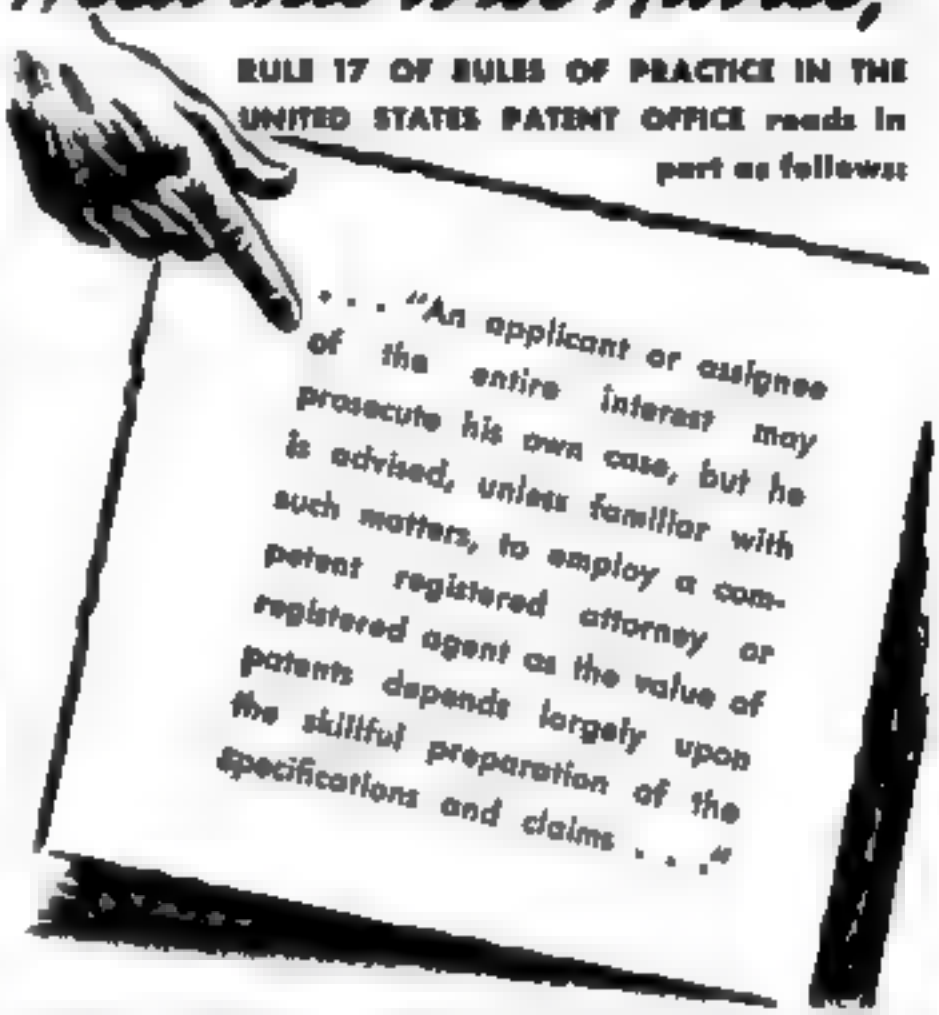

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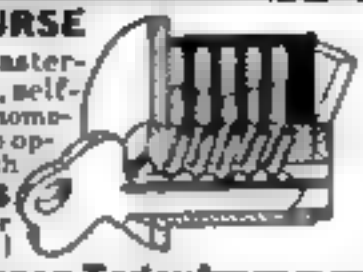

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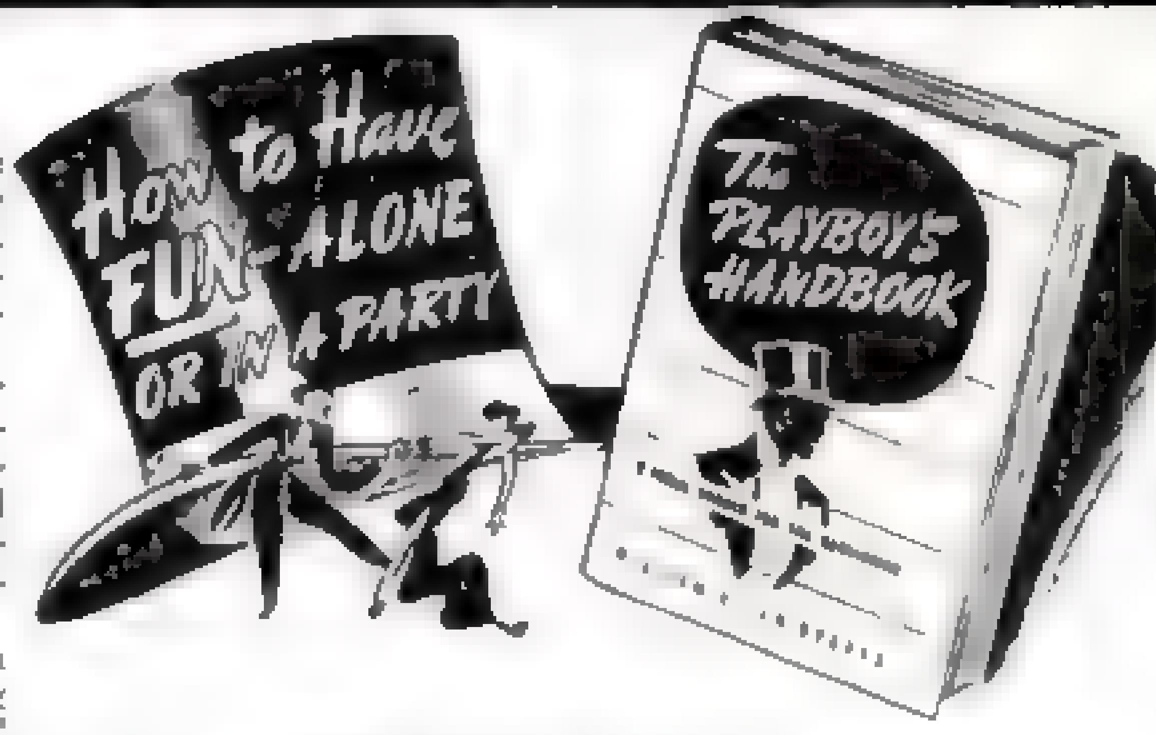

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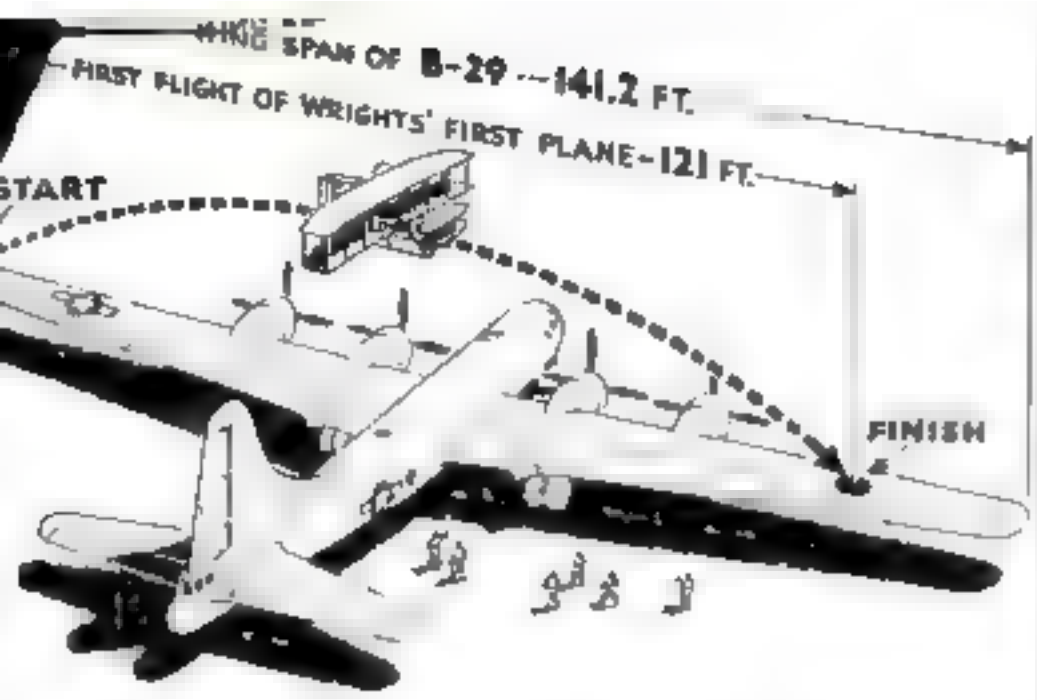
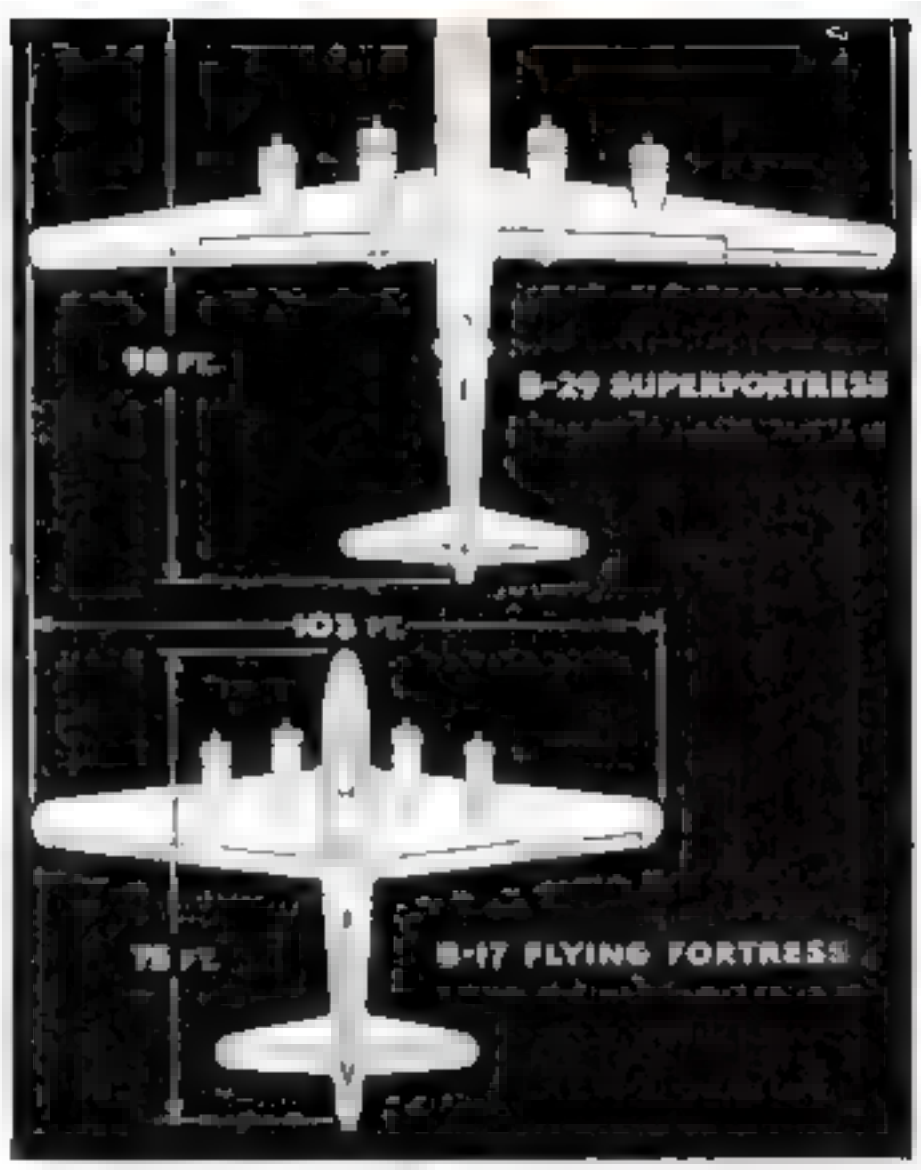


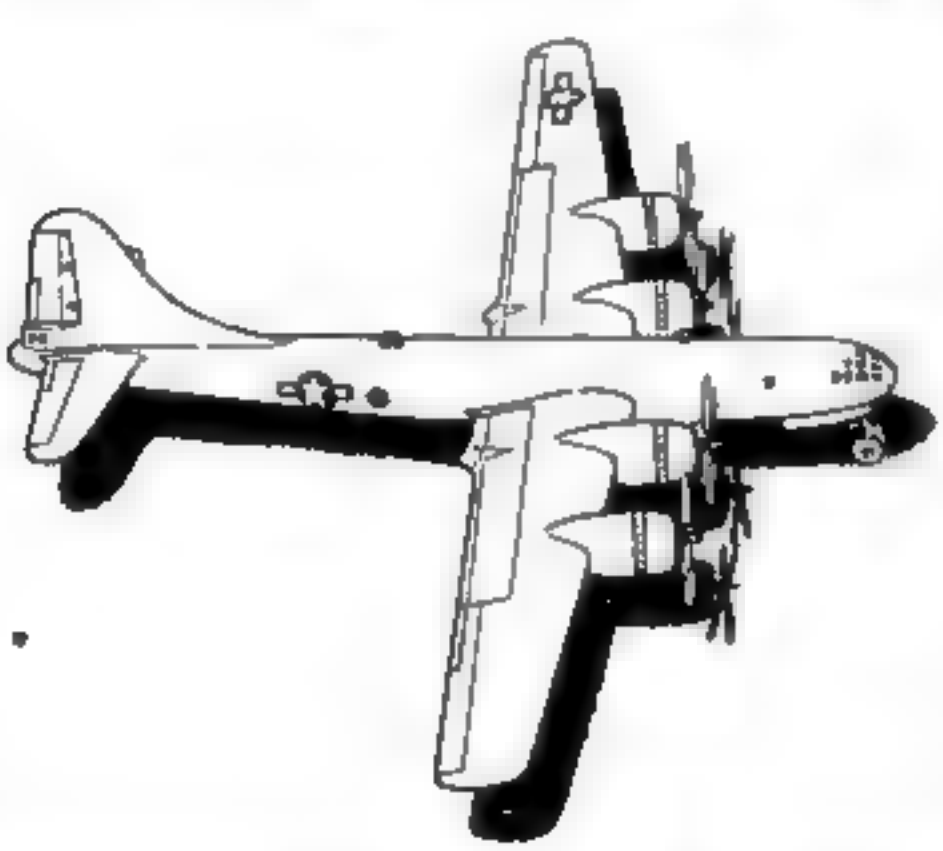


SIZE of the Superfortress is illustrated dramatically by the fact that the first successful airplane flight fell short by 20 feet of the wing spread of this new air giant. (Incidentally, the auxiliary gasoline engine that helps electric motors raise and lower the B-29's flaps has the same horsepower as the engine on the Wright plane.) The special Boeing "117" wing is unusually long and slender, with an aspect ratio of 11.5—practically the same as that of a soaring glider. This wing alone weighs as much as a loaded DC-3 transport. Silhouettes at right contrast the Superfortress with its "little" brother the B-17

The P-63 Kingcobra is a larger and greatly improved version of the Bell P-39 Airacobra. The P-59 Airacomet (P.S.M. Apr. '44, p. 85), heretofore regarded as a sort of trainer for jet-propelled aircraft, now appears to have been a fighter all the time, for the designation P-59A can only mean that it was designed for combat

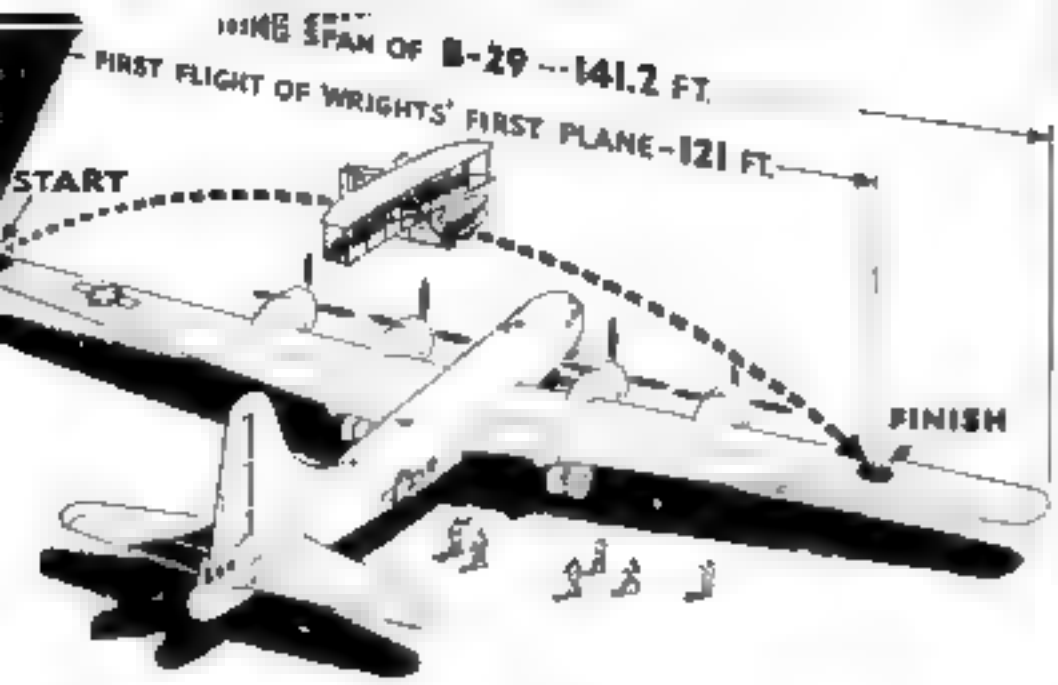
The P-61, designed exclusively for the night interception of enemy bombers, is the only American fighter to have radial engines along with twin tail booms, and the only military aircraft to use spoiler control in place of ailerons. (This feature was pioneered by Northrop on his little "flying wing" a few years ago.) It combines a top speed well over 300 m.p.h. with an unusually low landing speed of approximately 70 m.p.h., which makes night operation from difficult fields possible with a greater degree of safety than ever before. In addition to 20-mm. cannon and a power turret with .50 caliber machine guns, it carries special night-fighter equipment. The engines are 2,000-horsepower Pratt & Whitneys. Crew consists of two or three men.

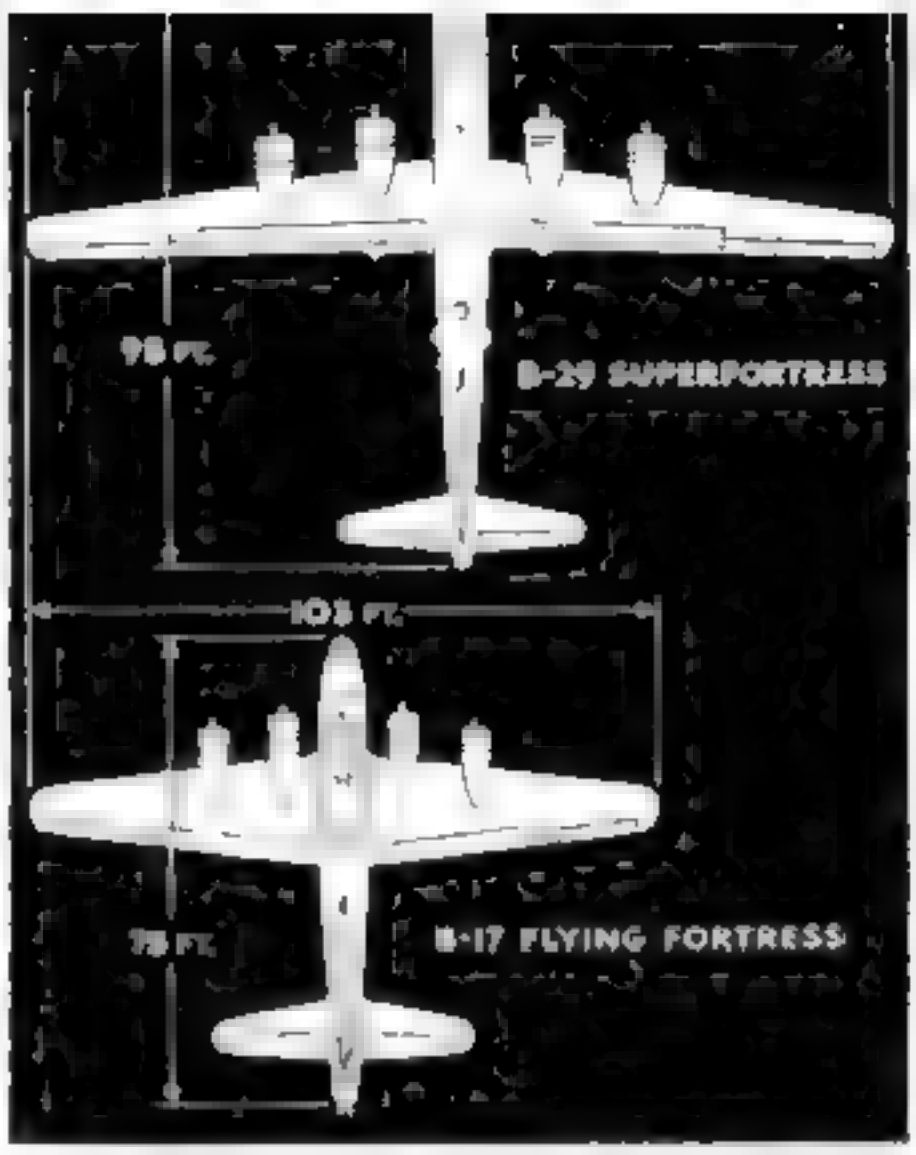
The Boeing B-29 Superfortress was designed to carry the air war to any part of the globe. Here are some little-known facts about this giant ship, whose fuselage is



B-29'S FOUR ENGINES HAVE THE POWER OF 103 AUTOS

The four-bladed propellers of these 2,200-horsepower Wright Cyclone engines turn more slowly than those of any other plane—only 35/100 of the engine speed—but because of their 16-foot diameter the blade tips travel at the usual speed. Like most other big planes, the Superfortress is designed to take bigger and more powerful engines as they become available. The cars compared above are 85-hp.





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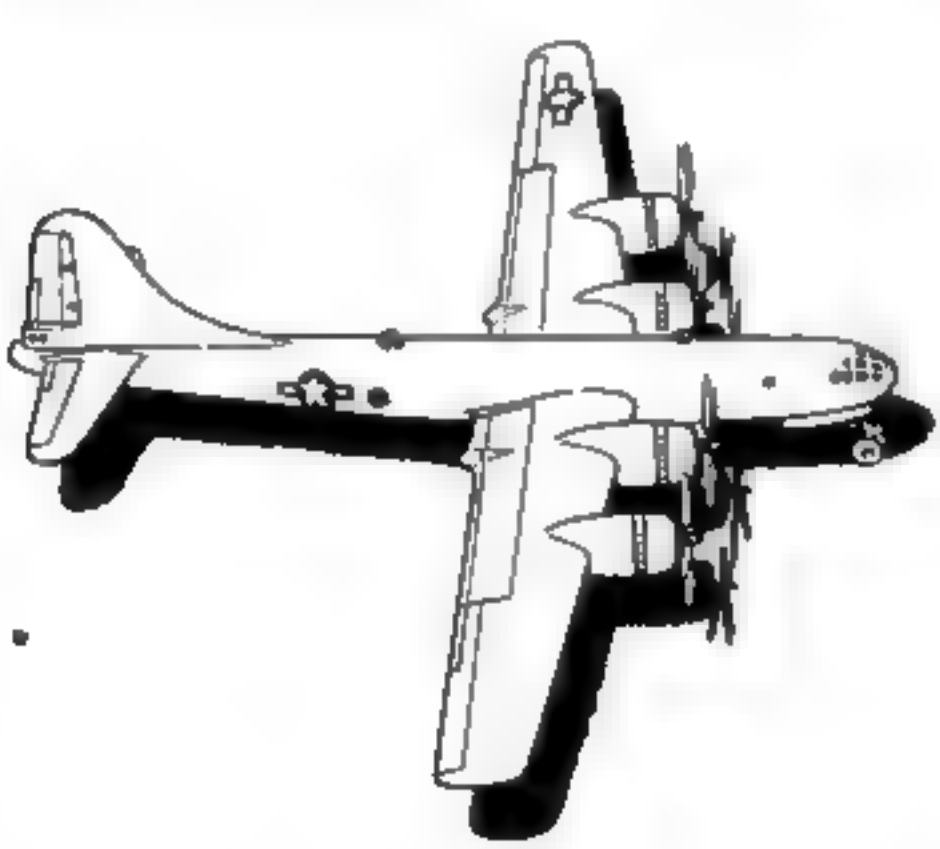

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almost big enough for a station wagon to be driven through from end to end

Although its operating altitude is officially announced as being well over 30,000 feet, on its first flight it flew to a height of but 15 feet. It was taxied about the field for two weeks before it ever left the ground. On September 15, 1942, it made its first flight—a short hop to 15 feet above the ground.

While the B-29 weighs about twice as much as the Boeing B-17 Fortress, it has no more drag when in flight than the smaller ship. Lowering the landing gear doubles its drag, while stopping two of its engines and letting the propellers rotate with the power off increases the drag by 60 percent. The B-29 is the most streamlined airplane in the world.

Within this streamlined shape are hidden many features that would delight the heart of a Ripley. A gooey zinc chromate compound around the windows never dries! This seals the glass securely against changes of pressure and checks vibration. A quilted, soundproofed blanket over the crew compartments is made of 40 percent genuine Japanese kapok. The plane has two complete electrical systems, one of 24 volts DC current and one of 115 volts AC. There is a four-bunk built-in hospital unit with first-aid and oxygen equipment.

The ship contains the first powered turret containing a 20-mm. cannon, and the clever gun sights hold the fire of the many guns until the enemy planes are within the correct range for sure hits.

Over 25 different materials, ranging from leather to magnesium, are used in the construction of this ship. One piece of magnesium, the largest casting of this precious lightweight metal ever used in any aircraft, will take a shock load of over 16,000 pounds without a whimper.

Only the landing gear is hydraulic, for this is the most nearly 100-percent electrically operated airplane in the world. (Owing to a slight "bug" in an early model, 580,000 electrical connections had to be resoldered.)

The metal skin of the ship would cover an area of over 7,000 square feet, or about one sixth of an acre. The Boeing "117" wing designed for this ship carries the heaviest wing loading ever imposed on any man-made pinions. Each square foot of this 141-foot wing will safely carry a small boy's weight. The preflight check takes nearly 45 minutes in the hands of five skilled crew members. Over 8,000 hours were spent in wind-tunnel tests of scale models and complete parts before the first flight tests. A year was spent in making clay models of the engine nacelles and testing them in the tunnel before the perfect shape was decided upon. Scaled-down sections of the tail surfaces were attached to a B-17 and flown before they were built for the B-29. The nose gear was scaled down and then tested upon another plane before the full-size gear was built. Much special equipment had to be constructed for these tests, ranging from tiny instruments to a building so gigantic that it was named "the Cathedral."

The final test required by the Army before the B-29 was accepted was for the entire ship, loaded with the equivalent of bombs, crew, guns, fuel, and equipment, to be lifted and dropped from a height of 27 inches in a free fall. The ship came through this test twice, once in a horizontal and once in a canted position.

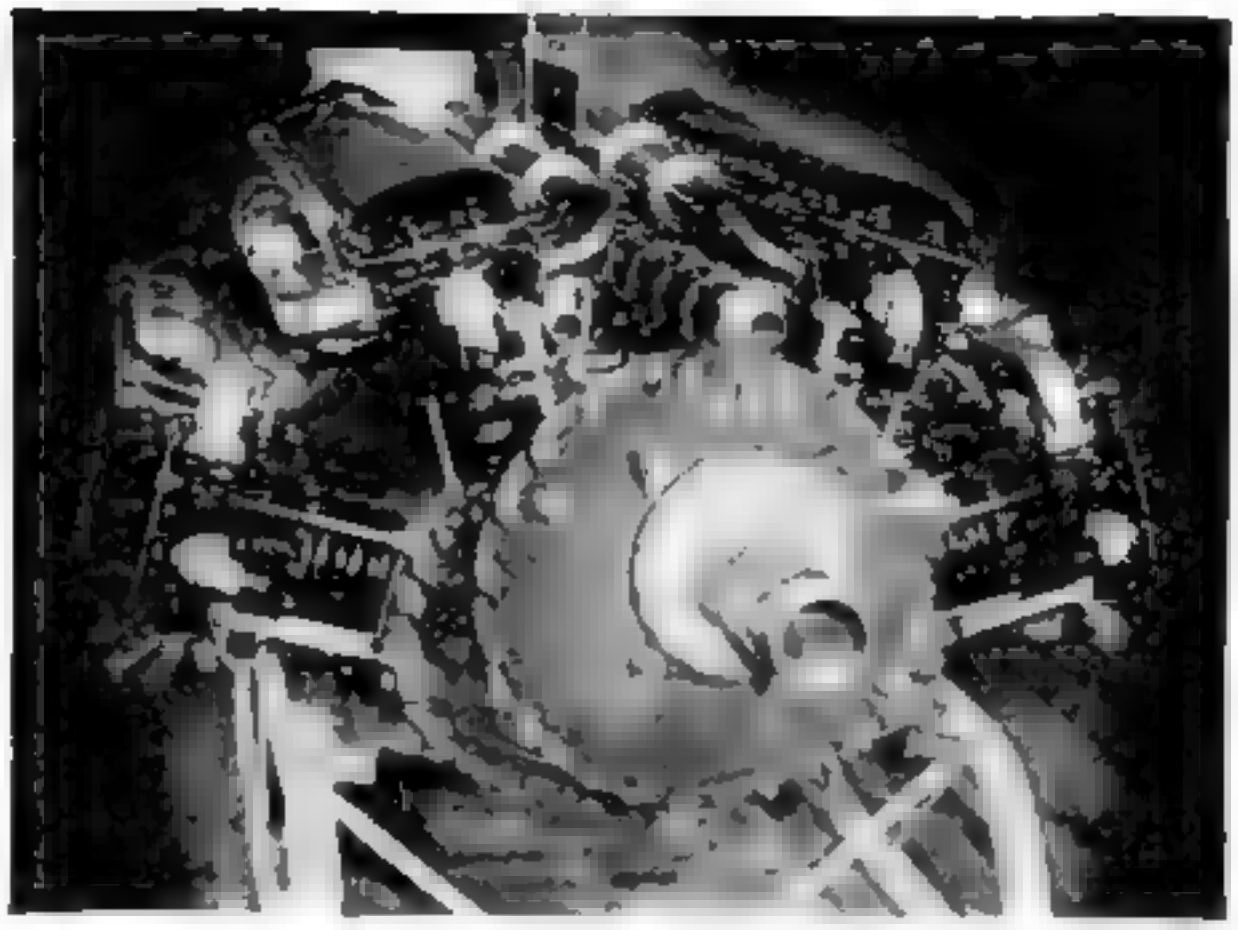
There are built-in ash trays for the crew members, luxurious seats, cushions, and hangings all in restful green to reduce combat fatigue. Special air conditioning and ventilation help keep the crew fit to fight, while heaters keep trigger fingers nimble at high altitudes.

The bomb bay *(Continued on page 254)*

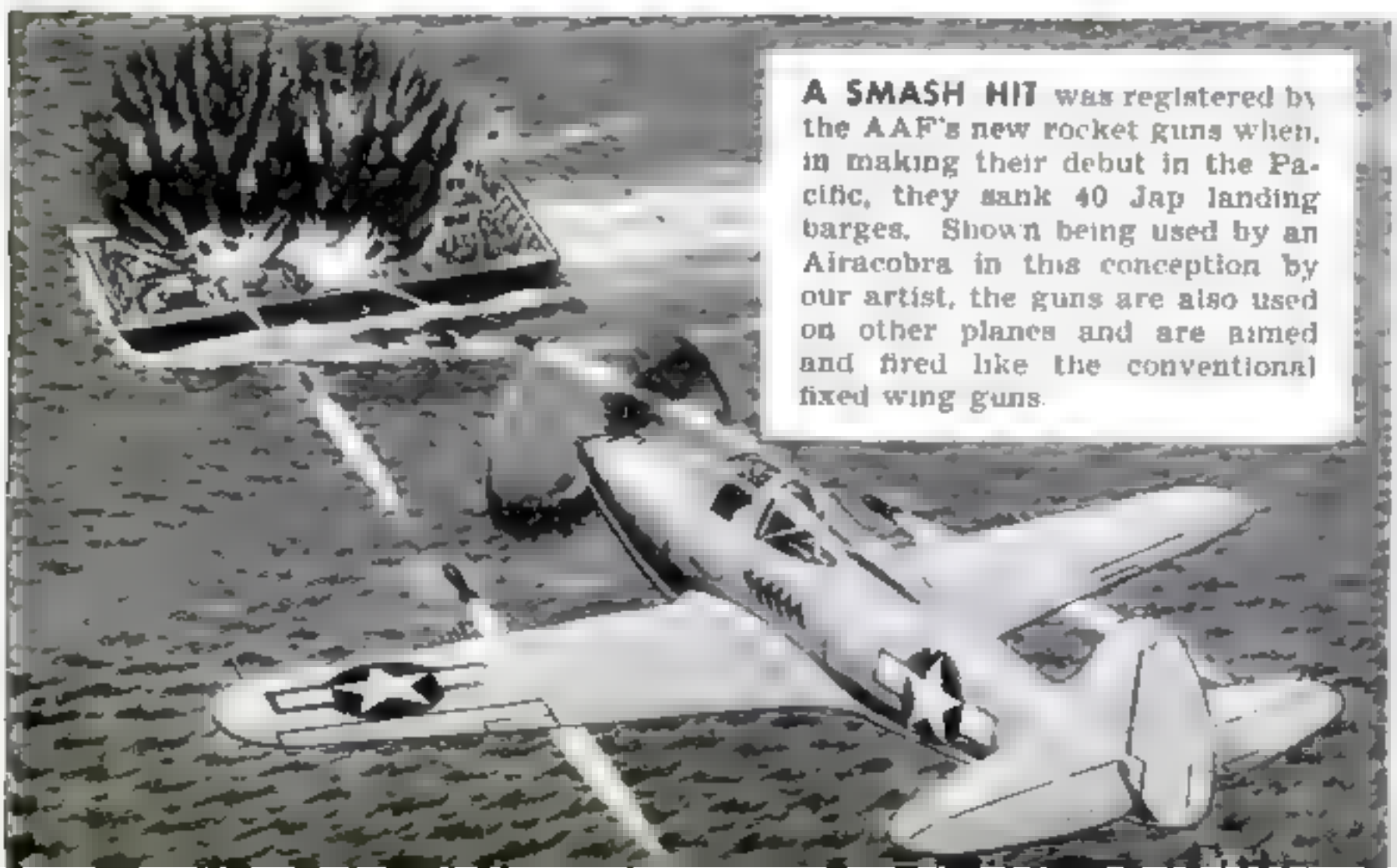
LANDING GEAR of the B-29 weighs more than three tons, while the nose gear alone is heavier than a loaded light plane. The three-foot dual nose wheel casters and the plane is steered on the ground by braking the main gear and varying speed of engines. At right, the Superfortress is compared with a Culver Cadet

B-29 WITH WHEELS DOWN NEEDS AS MUCH POWER TO PULL IT THROUGH AIR AS TWO B-29'S REQUIRE AT THE SAME SPEED WITH THEIR WHEELS UP

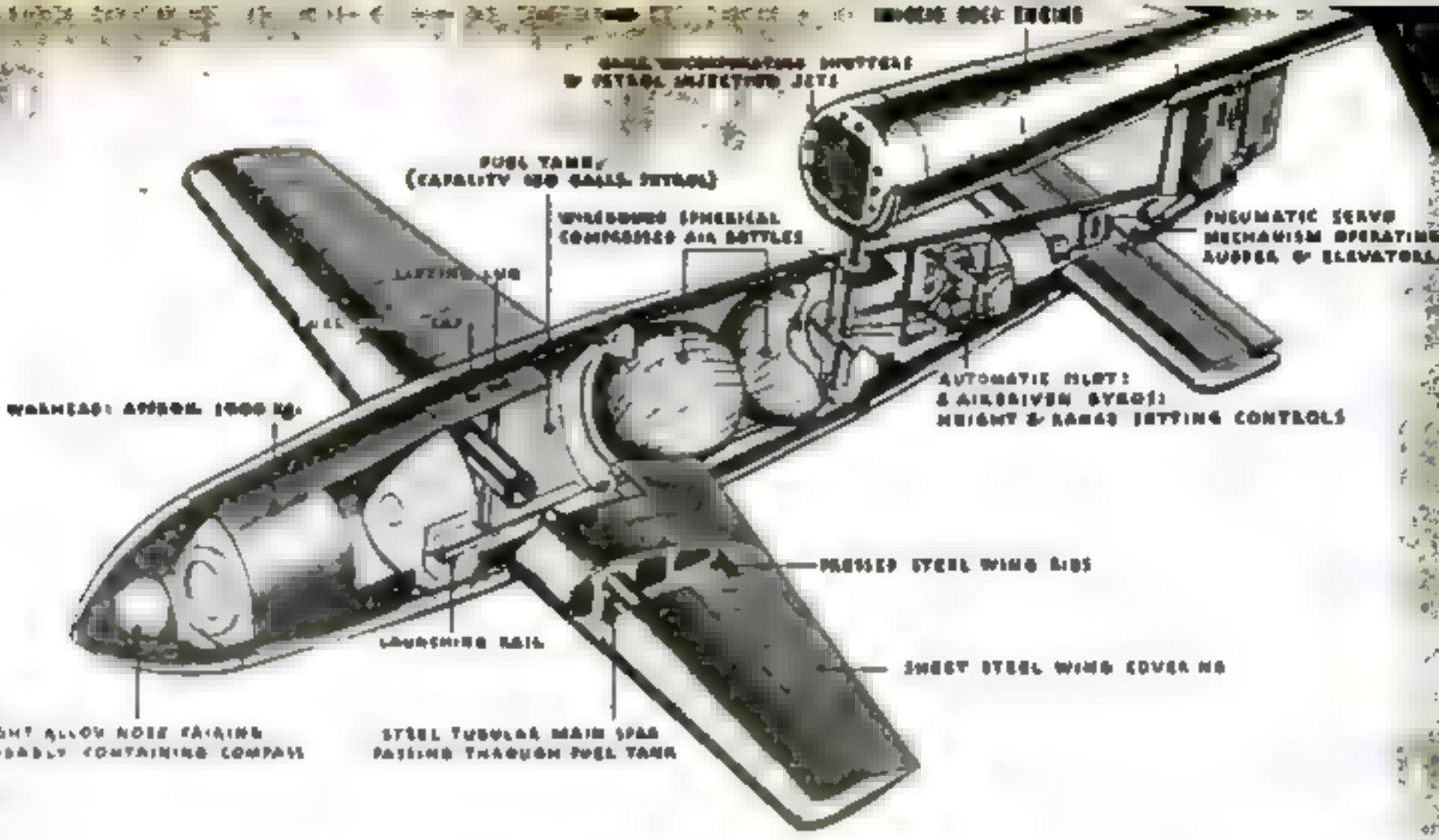
MOST POWERFUL aircraft engine in the world, the new air-cooled Allison now in production for the AAF promises to add several hundred horsepower to most of our single-engined fighters. Rated at approximately 3,000 hp., it has 24 cylinders arranged in four banks of six cylinders each and weighs considerably less than a pound per horsepower. As a result of simplified design, 97 percent of the new engine's parts are interchangeable with those of the Allison V-12, which now powers the P-38, P-39, and P-51.



THUNDERBOLTS will hit our enemies harder than ever now, with the improvements being incorporated in the P-47 by Republic Aircraft. These new features include an entirely new silhouette, an electrically operated "bubble" canopy that gives the pilot "around-the-clock" visibility, increased engine power, and larger internal fuel tanks that double the ship's range. As a fighter-bomber it can carry up to a ton of bombs.

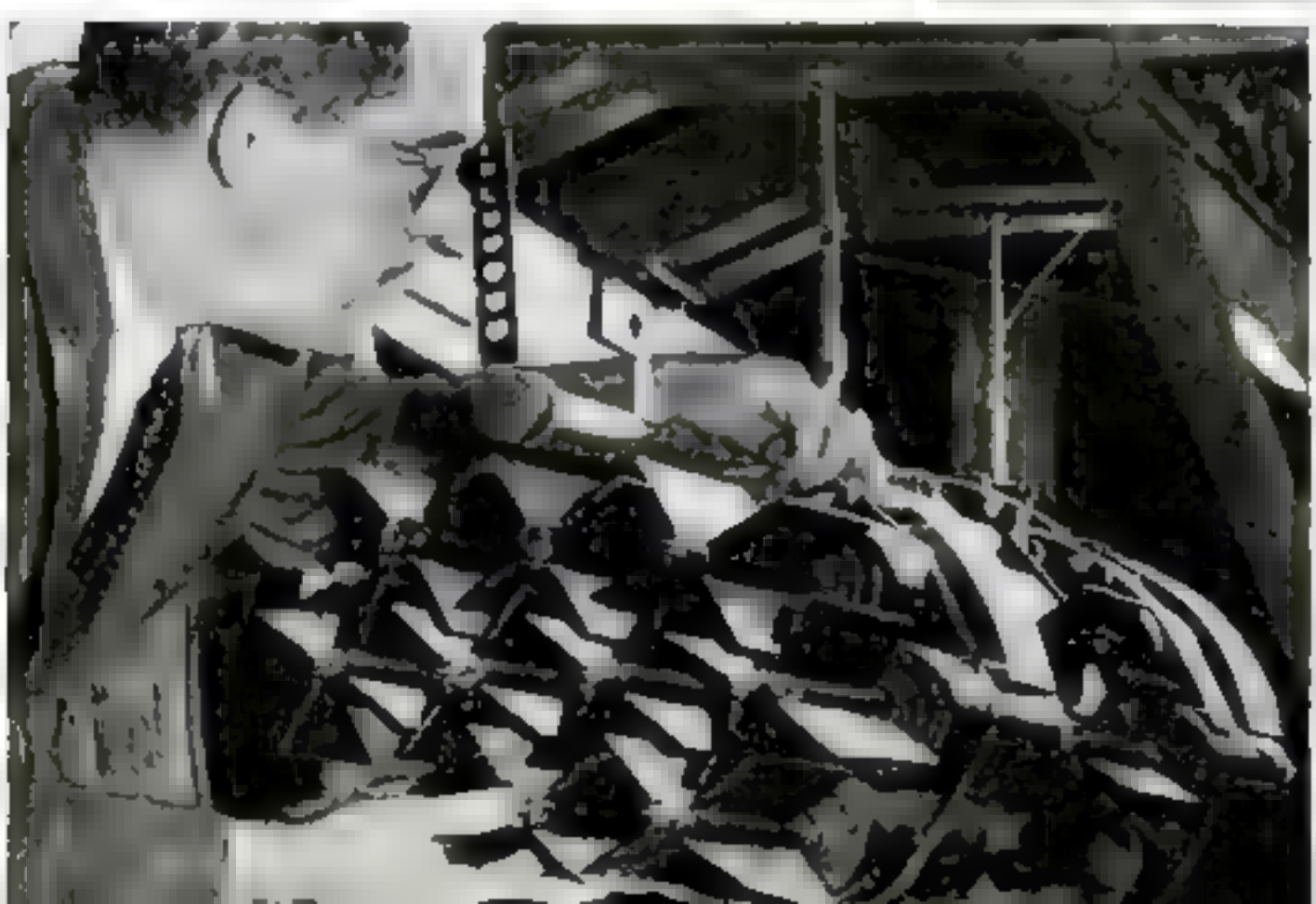


A SMASH HIT was registered by the AAF's new rocket guns when, in making their debut in the Pacific, they sank 40 Jap landing barges. Shown being used by an Airacobra in this conception by our artist, the guns are also used on other planes and are aimed and fired like the conventional fixed wing guns.



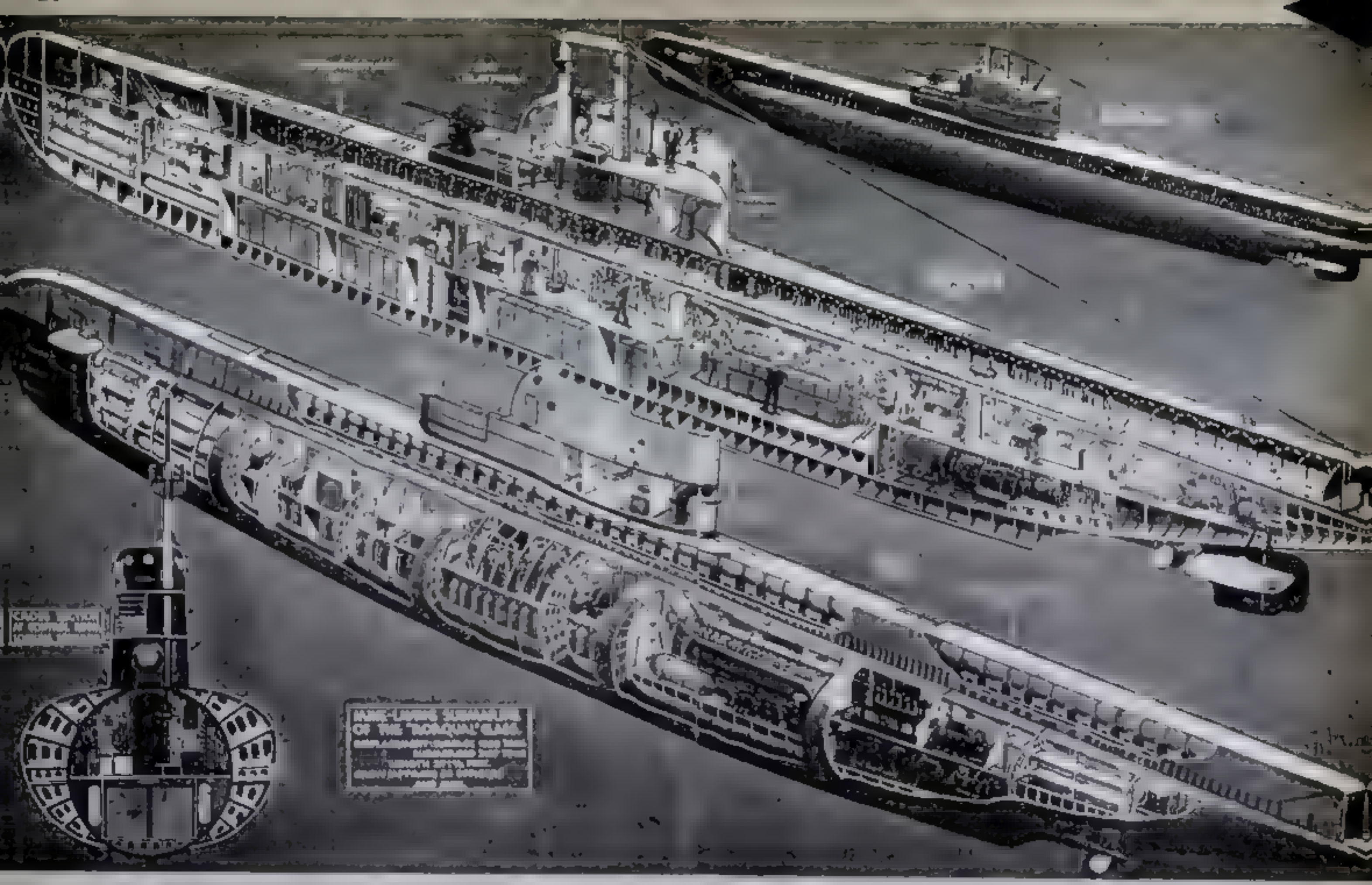
"ROBOT PLANES" used by the Nazis in their abortive counterinvasion terror attack on England are now revealed as jet-propelled, gyroscopically controlled miniature aircraft carrying heavy charges of high explosive. The "provisional" sectional drawing above, reproduced from a British official photograph, shows details learned from an examination of specimens shot down by the RAF. Installations found intact in Normandy indicate that the Germans used two types of planes, plus ordinary rockets.

FRAGMENTATION BOMBS that are carried and dropped in clusters by a new device developed by the AAF's Matériel Command are proving more deadly than ever to the enemy's troops and grounded planes. Strapped together to form a compact unit, a large number of these bombs can be carried in any service bomb rack. On release, an arming wire frees the straps and the cluster breaks apart in the slip stream. In a predetermined dispersal pattern the bombs stabilize and arc down to the target. As each bomb hits, it scatters its shrapnel to a distance of 200 feet in every direction.



A cluster of fragmentation bombs attached to the fuselage of a Thunderbolt and ready to be showered on the enemy. On release, the cluster will break apart quickly in the plane's slip stream

W. M. Neff, supervisor of Matériel Command's Bomb Rack Unit and developer of the new bomb-dispersal method, looks over one of the clusters



MINE-LAYING SUBMARINES of the British Royal Navy sow destruction in enemy waters, disrupting seaborne supply lines. Key features of these specialized underwater raiders can be seen in the detailed drawing above, made by G. H. Davis for The Illustrated London News. Fifty mines are carried in a superstructure running the entire length of the vessel just below the conning tower. For laying, a mine rolls on its wheeled base along a track and through a door at the stern. The cross-section view shows position of the mine track. In addition to its difficult and dangerous task of setting traps for enemy ships the mine-laying sub is prepared for offensive action. Six torpedo tubes in the bow fire standard 21 inch "fish" carried in a torpedo compartment forward. The conning tower mounts a four inch dual-purpose quick-firing gun and a smaller antiaircraft weapon. On one stretch of duty in the Mediterranean, the first submarine of this class not only laid 1,200 mines along enemy supply routes, but also sank 40,000 tons of shipping, and shot up Axis shore installations.

SMITH THREE-INCH GUN adopted for use by the British Home Guard rolls into action on two huge disk wheels, towed by a ring at its muzzle. For firing, it is tipped over so that one wheel becomes the base and the other a top shield. The smoothbore weapon (really a breech-loading mortar) throws two kinds of eight-pound projectiles, one with vanes, carried on a limber built like the gun carriage.

DON'T BOIL A COMB unless it is made of Cerex. That's the moral of the picture shown here. Cerex is a new heat-resisting plastic made by the Monsanto Chemical Co., St. Louis, Mo. The picture shows an ordinary comb gobe limp from boiling, while its Cerex companion is unaffected. The entire production is now being devoted to war uses in which the requirements are resistance to heat and corrosive chemicals, high insulating qualities, and great strength. Future applications to industry include a large variety of everyday items ranging from teething rings and bottle warmers to poker chips and automobile and electrical accessories. The chemical composition is secret.

MOBILE POWER UNIT is an eight-car train to supply electric energy to wrecked cities recaptured from the Germans. Made by Westinghouse, this is the first roving power station completed for use abroad. It produces 5,000 kilowatts of power, which is enough for a community of approximately 10,000 persons. The cars below contain equipment for condensing spent steam issuing from the turbine generator.

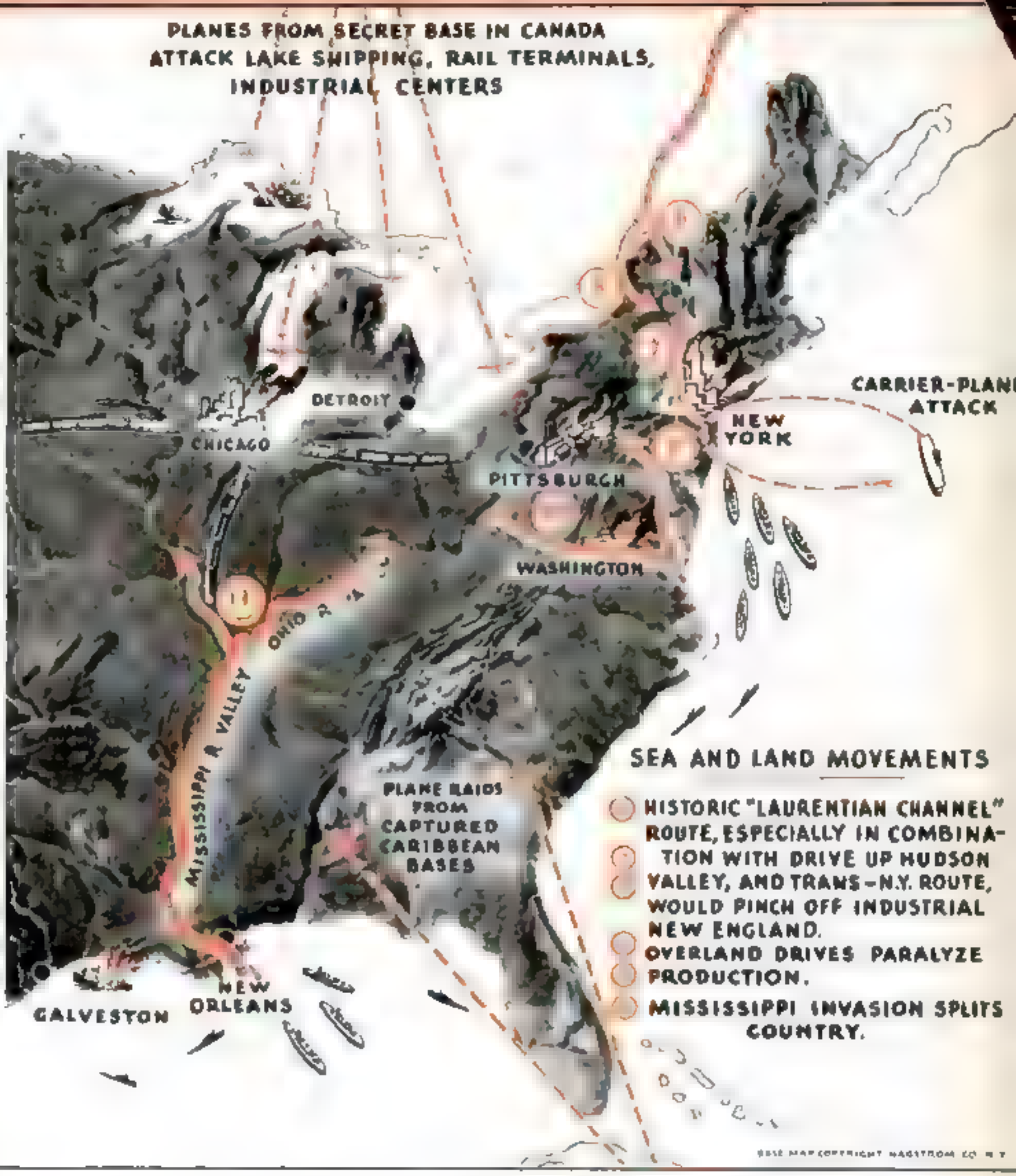
THIS IS HOW A DEFENSELESS

How America's future will be guarded . . . .

What's Being Planned for Our Postwar Battle Strength

We're to keep the world's most powerful navy and expand its range with giant floating dry docks . . . We'll have a strong army, maintained by universal

AMERICA COULD BE INVADED



By ALDEN P. ARMAGNAC

HOW big an army, navy, and aerial armada should the United States maintain after the war is won?

None too soon can this question be asked even amidst the heat of battle, the roar of artillery, the blast of bombs. For the future armed might of America and our Allies may well decide whether or not we can prevent a World War III—a holocaust that would make its predecessor seem tame by comparison

What are you going to do about it? In striking contrast to countries like Germany and Japan, where the military holds the reins of government, the United States employs armed forces established by the peo-

service and armed with new weapons...And our air forces will be maintained at top efficiency by research and a farsighted replacement program.

ple and subject to their will. Our Army and Navy can do no more than recommend how many men and what equipment they need. You, through your Congress, have the final say.

Let's look at some of our postwar problems, then, and see how they may best be met. As far as possible, this article represents the views of those best qualified to speak for the Army, the Navy, and Congress. Wherever statements are not specifically quoted, however, they are to be taken as the opinion or speculation of the writer.

At the outset, several basic considerations seem to offer a foundation for this country's postwar military program.

First, we have already taken preliminary steps in international negotiations for a postwar council of powers for the suppression of war, a project which in principle can only be heartily approved—as evidenced by the endorsement of public leaders regardless of political party lines. It would be less than frank to fail to acknowledge, however, that no man knows how long it may take to work out all the details of such an organization. Quite possibly it might not be ready to function until some time after the war. One widely discussed plan calls for a World Assembly of the more than 30 United Nations, grouped as an advisory body around an inner World Council consisting of the "Big Four" military powers—the United States, the British Commonwealth, the U.S.S.R., and China. It would derive its "teeth"—an International Police Force—from voluntarily contributed armed power under the individual control of member nations. *Therefore, there need be no inconsistency between such a plan, and land, sea, and air forces designed to meet the immediate and particular needs of the United States*

Second, we might as well realize that our decades of immunity from overseas attack, thanks to the natural barriers of two great oceans, have come to an end. We remember Pearl Harbor, and we have seen Alaska bombed and—temporarily, at least—invaded. Our own Navy's giant flying boat Mars, of which 20 duplicates are on order as cargo craft, can cross the Atlantic and return without landing. True, most of its load would have to be gasoline—but it would be rash to deny that superplanes of the future will carry bombs, too. And why restrict an enemy to nonstop flights? Consider the amazing air routes we have developed during this war—for example, the 11,500-mile, 84-hour "Cannonball" air express from this country to India—and reflect that with the bases in hostile hands, the planes might be flying the other way. Early in the war, one of America's largest steel-making firms in-

A BALANCED PROGRAM

Here are the main elements of a suggested plan for America's peacetime defense program. Views expressed are those of the writer and not official statements of the War or Navy Departments

ARMY. The largest standing army in our peacetime history, although not approaching our wartime peak. Universal military service for young men, to consist, say, of one year's training after high school and periodic "refresher" courses in subsequent summers

AVIATION. Army and Navy air arms of perhaps one-third present war strength, inseparably coupled with: (1) Constant research to develop improved plane types. (2) An orderly program for replacing a given per-

ONLY ARMED PREPAREDNESS CAN KEEP OVERSEAS INVASION ARTERIES FROM BEING TURNED AGAINST US

FOR POSTWAR PREPAREDNESS TO GUARD THE PEACE

centage of obsolescent planes yearly. (3) Orders for military types to keep manufacturers ready for emergency production.

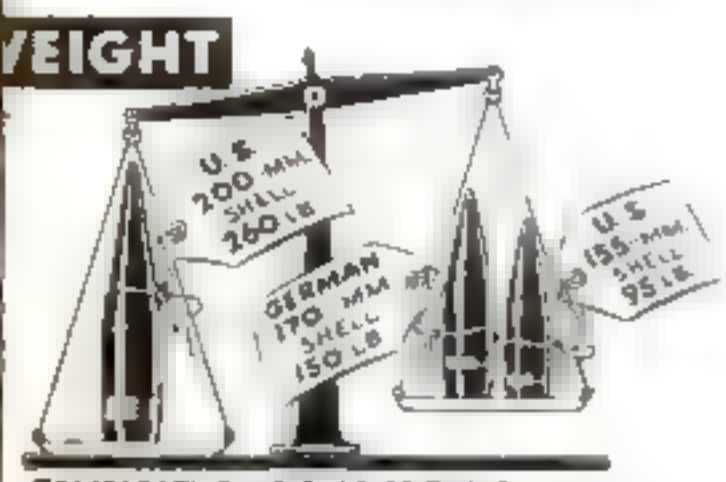
NAVY. All large warships to remain in service. Some smaller vessels to be laid up or transferred to friendly South American countries. Control of the seas to be shared with Great Britain, until an international police force is set up. Bases acquired by war action to be retained where needed as naval outposts. New naval strategy based on use of floating dry docks for total mobility of fleet

CRITICAL MATERIALS. Permanent stockpiles of war metals and other essential supplies not available in the U S Domestic mines to accumulate readily accessible supplies of minerals above ground ready for instant use in emergency

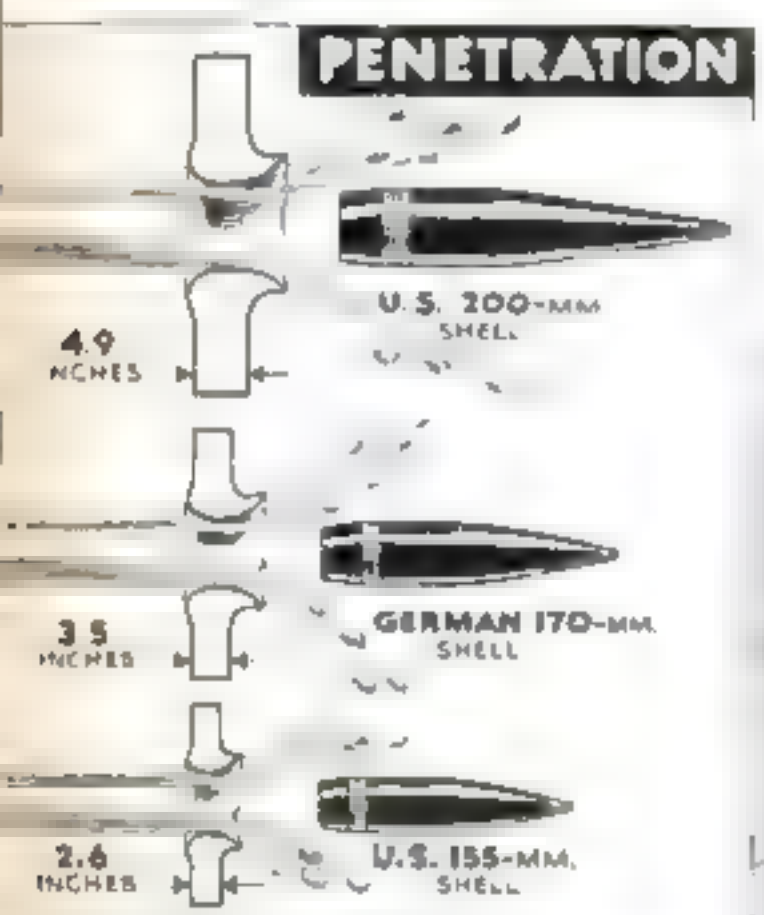
FOREIGN AFFAIRS. Recognition of the fact that oceans no longer isolate this country from others overseas. Full co-operation with all peace-loving nations in forming a world association to deal with global problems. One primary aim of this body, to promote peace, as by efforts to assure equitable distribution of the world's resources. Secondly, to act as the highest court of arbitration for international disputes. Finally, to provide for joint use of armed force against gangster nations, on such a scale as to be immediately effective under any conditions without jeopardizing the national security of any member country

WE MUST KEEP OUR LEADERSHIP IN DEVELOPING WEAPONS

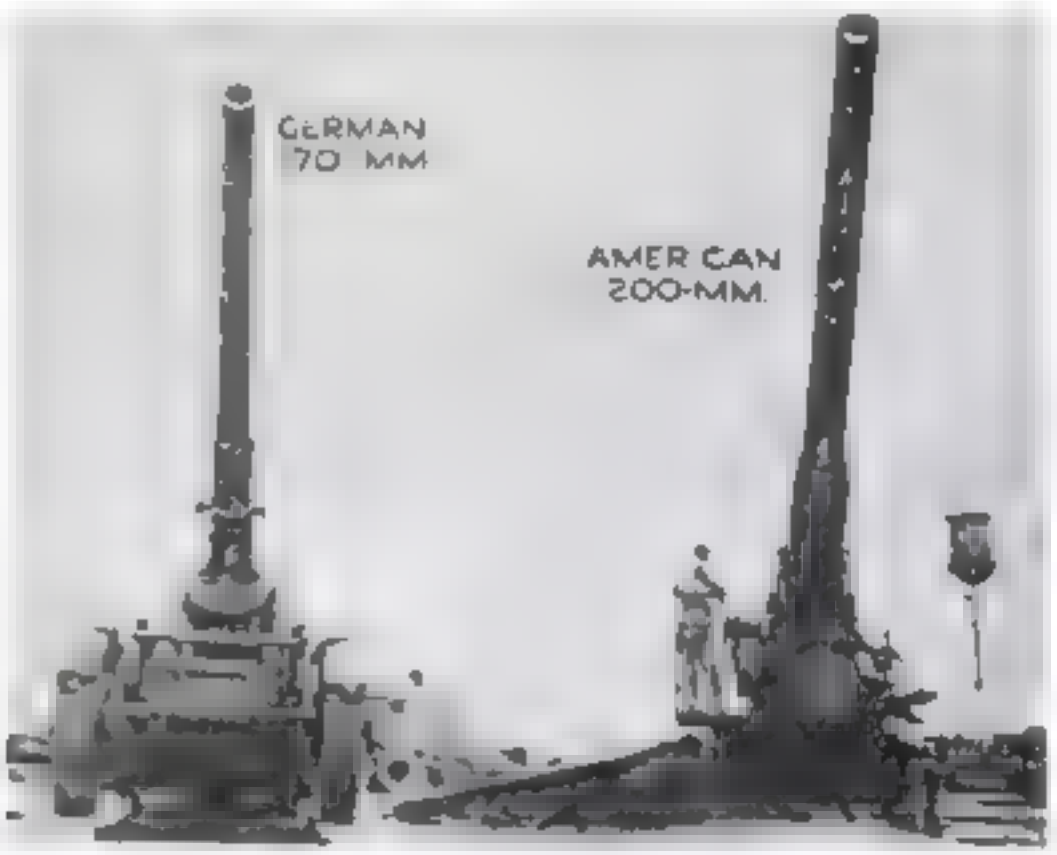
Just as the acknowledged superiority of American ordnance has proved a decisive factor in the present war, so our ability to build better weapons and more of them will be remembered by would-be world conquerors of the future. An example of the powerful guns that will guard the peace is our new 200-millimeter gun, shown in the photograph below alongside a captured German 170-mm. piece under test at the Aberdeen (Md.) Proving Ground. In the drawings, the performance of the new U. S. heavyweight slugger is compared with that of the German weapon and also of the U. S. 155-mm. gun. Note that the 200 throws a projectile nearly twice as heavy as the one hurled by the Nazi gun, and throws it nearly two miles farther. If we are to maintain our leadership in ordnance, we must not repeat our old mistake of losing ground by letting research and replacement languish as soon as the war has ended

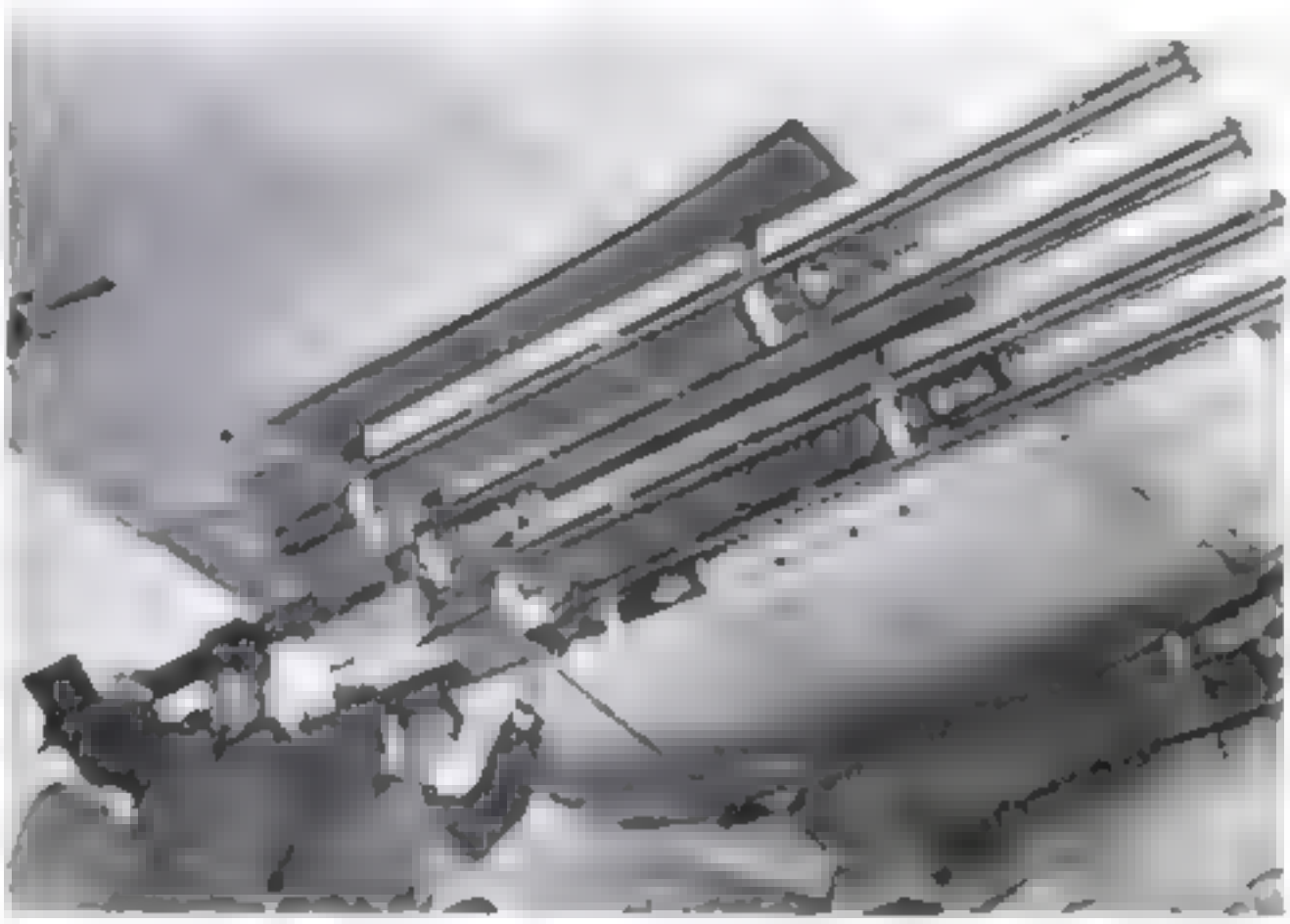


COMPARATIVE WEIGHTS OF THREE TYPES OF HEAVY-ARTILLERY SHELL



COMPARATIVE PENETRATION OF KRUPP CEMENTITE ARMOR PLATE BY SHELLS AT THEIR MAXIMUM RANGE





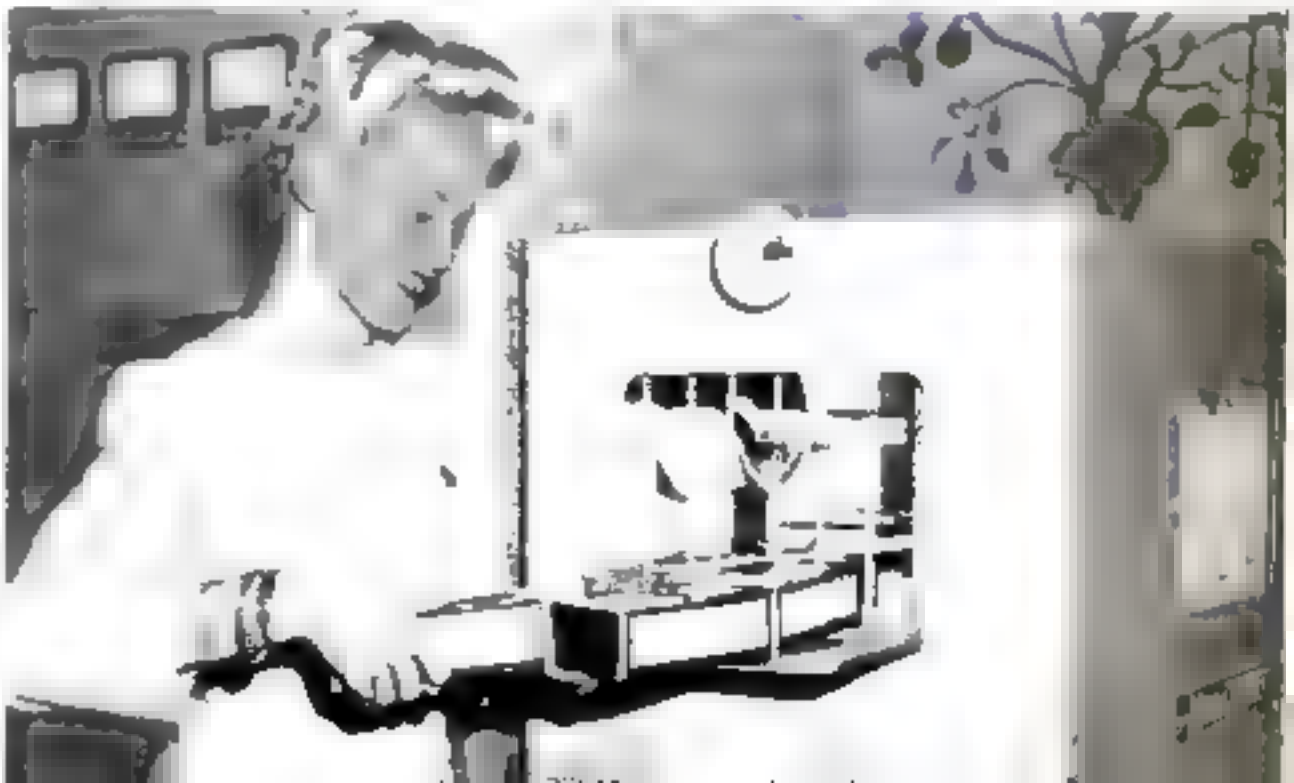
ROCKET WEAPONS will probably play a large part in postwar preparedness programs. Here a Beaufighter of Britain's R.A.F. Coastal Command has just fired two rocket projectiles. Note the trail of rocket vapor partly blanketing the tail assembly

Ground crewmen loading the rocket projectiles into the guide rails under a wing. Four rockets are carried on each side. They can be fired in pairs, or all eight in one salvo. Beaufighters armed in this manner have taken a heavy toll of Nazi shipping in the North Sea

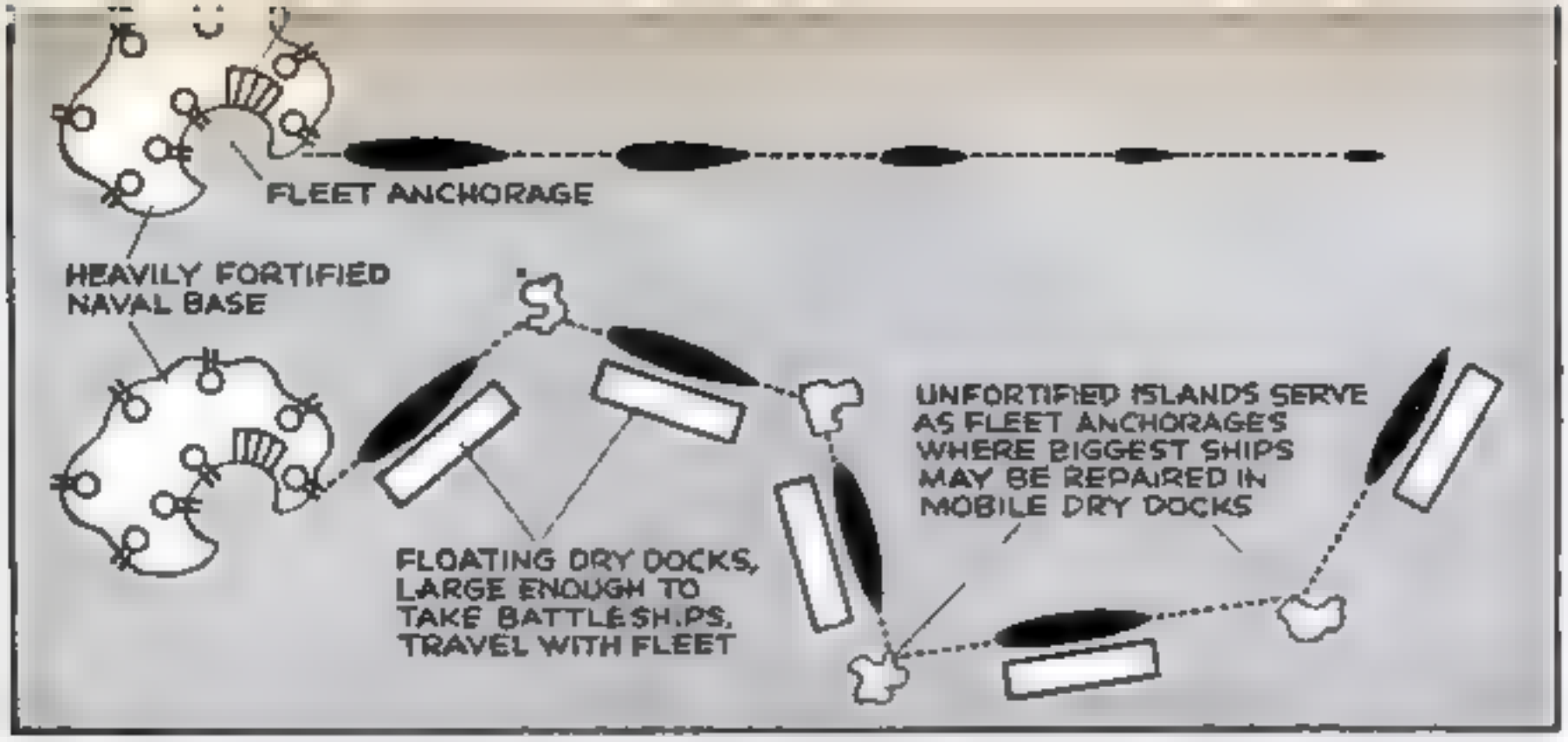
stituted elaborate air-raid precautions at its Chicago, Gary, and Pittsburgh plants, anticipating the possibility of inland bombing from a base in Greenland or, perhaps, in the sparsely settled neighborhood of Hudson Bay in Canada.

But are we going to wait until an enemy sets up bases within convenient striking range and launches upon America the ravages of "total warfare" against men, women, and children that Europe already knows only too well? Twice before, our Allies-to-be have gained us precious hours to prepare, by doing our fighting for us. We dare not count on being as lucky again. At the first threat of trouble, we must be prepared to carry the war to the enemy—to blast his outposts with long-range bombers, to bring his ships under the guns of our own, and to rush fast troop convoys to hurl back his advance.

Because preparedness costs money, wishful thinkers prefer to believe that each war will be the last, and let the armed forces get along as best they can on a pittance during peacetime. If they only knew it, the price of a battleship or a coast-defense gun is a mighty worthwhile insurance premium against war. A bully thinks twice before picking on a big fellow. And if war does come, how much better to have invested in a balanced preparedness program, from year to year, than to be forced to the more extravagant, hang-the-expense expedient of trying to create a military machine overnight! *(Continued on page 70)*



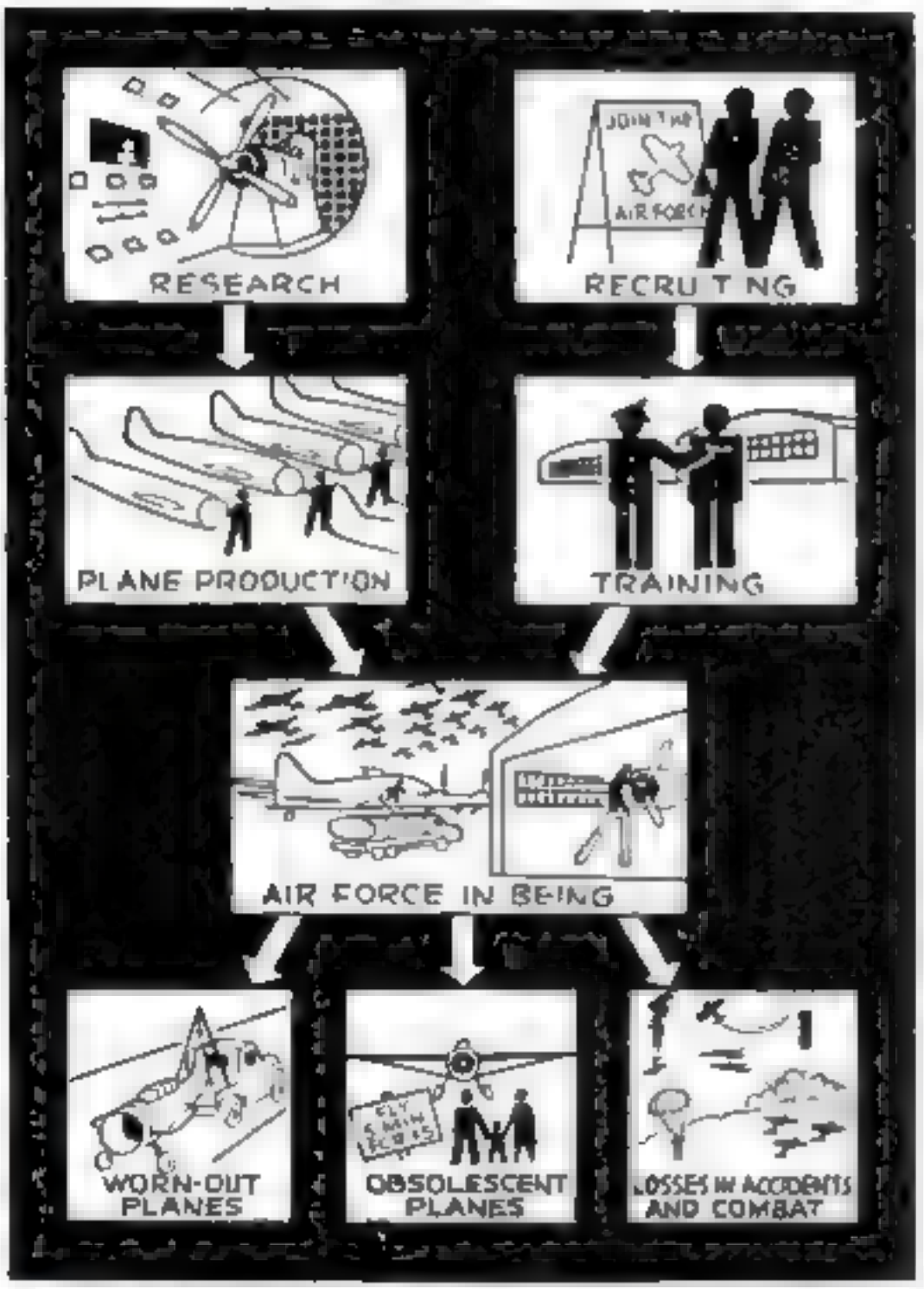
FOOD preserved by modern methods will enable us to keep our reserve fighting ships victualed for instant action (see page 71). This is a demonstration model of the Megatherm, which sends high-frequency waves through food to kill germs



FLEET FIGHTS FAR FROM HOME IN NEW NAVAL STRATEGY

Postwar naval planning will be based on the concept of a mobile, self-sufficient fleet. In the past, a navy was tied to its fortified bases and its battle strength dwindled in proportion to the distance from the nearest base, as represented by diminishing silhouettes in the upper part of the drawing. Big ships could not operate far from dry docks large enough to repair them after damage in battle. Now, with huge floating dry docks accompanying the fleet, any anchorage becomes a naval base and striking range is almost unlimited. This new strategy explains the daring advance of the U. S. Navy in the Far East

MAINTAINING AN AIR FORCE means more than just having a given number of planes and flyers. Research and production must replace losses by wear, obsolescence, and accident. Personnel must be constantly replenished by training

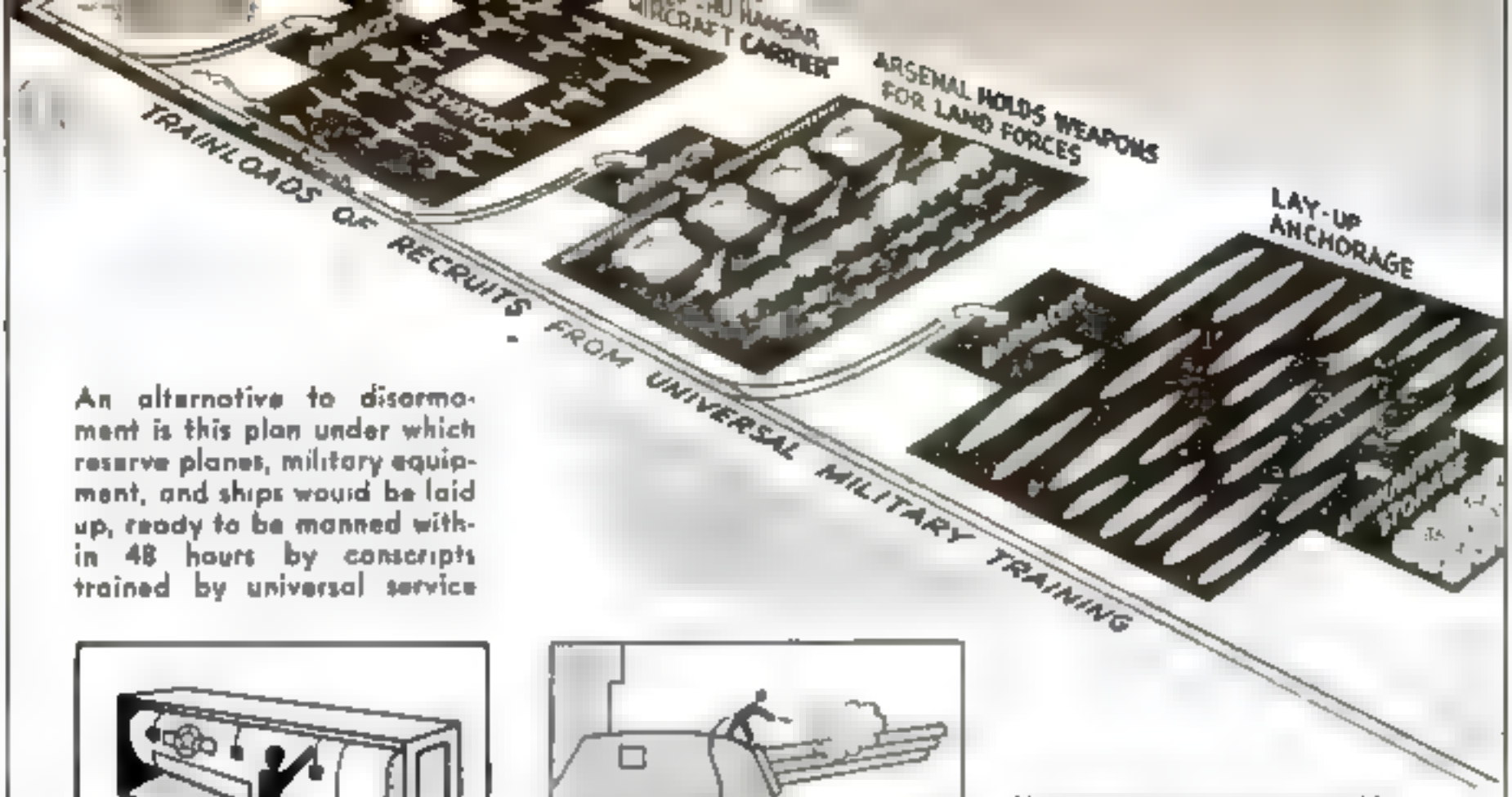


Of course it would be a staggering burden upon the taxpayer to maintain our forces on a permanent war footing, and no one expects to do it. By combining wise economy with farsighted planning, it should be possible to keep the United States in the front rank of military powers.

And now to get down to brass tacks, and see how these considerations would shape our future Army and Navy, and their respective air services.

In attaining its full wartime strength of 7,700,000 men plus the recruits now being used as replacements, the Army has found itself too close for comfort to the absolute limit of American manpower. Its present force numbers more than twice the one it raised in World War I. Agriculture and vital factory occupations, more important to war effort than ever before, keep whole divisions immobilized on the home front. More startling, in the eyes of military doctors, is the alarming proportion of rejections, for physical defects, among men of prime military age.

Universal military service, such as European countries have long found necessary, would offer a two-way benefit to American boys, Brig Gen. John McAuley Palmer recently told the House of



An alternative to disarmament is this plan under which reserve planes, military equipment, and ships would be laid up, ready to be manned within 48 hours by conscripts trained by universal service

"MINUTE-MAN" MOBILIZATION

Laid-up machinery would be protected against rust by silica gel, calcium chloride, and other moisture-absorbing chemicals. Modern metal preservatives, applied with a spray gun, would coat exposed surfaces with a corrosion-resisting film that can be removed at short notice. Coded alarms, reporting conditions of alert, danger, and action (right) would signal for successive steps in the elaborately planned procedure of putting the nation's defense setup into motion

CODED ALARMS

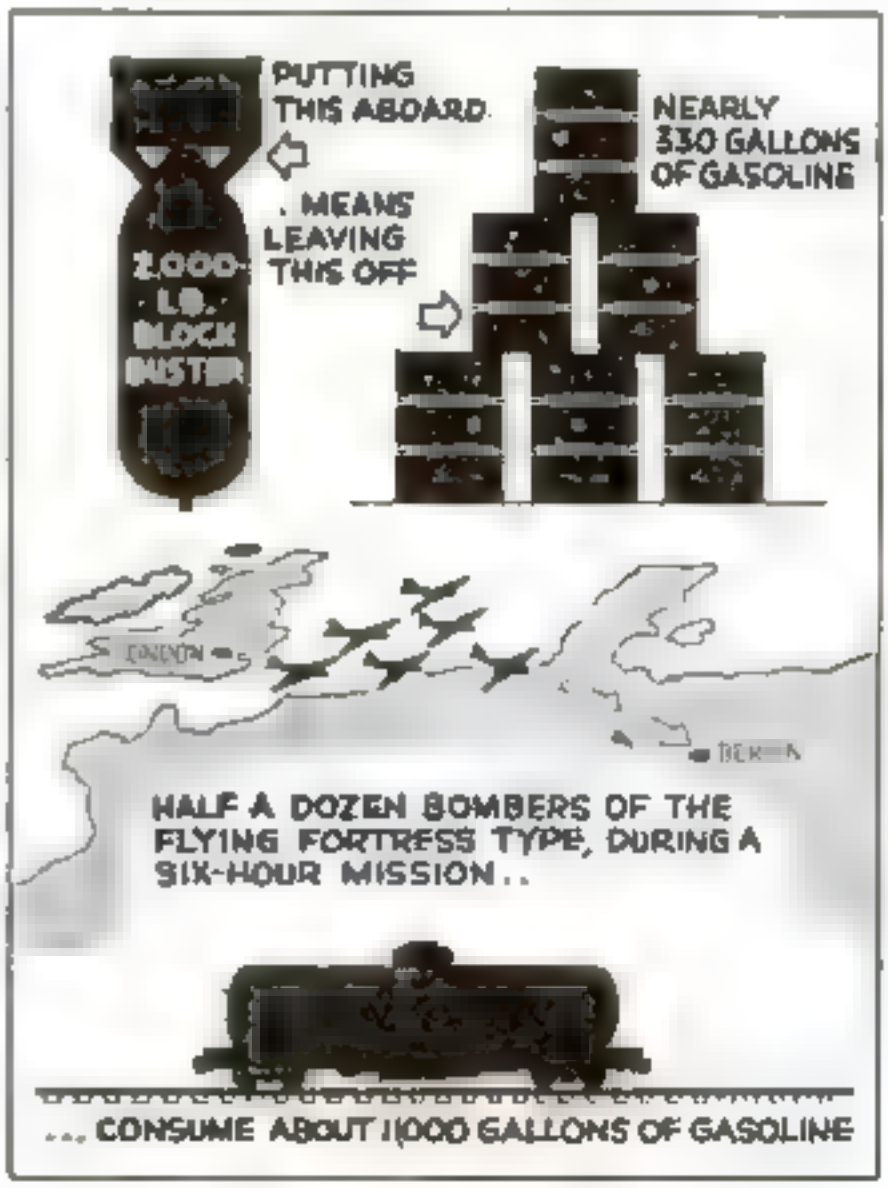
ALERT- SUMMON PERSONNEL AND MAN SHIPS, LAND VEHICLES, AND PLANES

DANGER- PREPARE ALL ARMS FOR ACTION

ACTION- SHIPS TO SEA, PLANES UP, DIVISION TO REPORT TO ARMY HEADQUARTERS

Representatives' Select Committee on Postwar Military Policy. Its immediate purpose, of course, would be to train them as potential soldiers. And if need be, who would not rather fight for his country—and his own skin, too—with long experience to rely upon, than as a comparative novice?

At the same time, General Palmer points out, the proposal would prove a boon to the physical and mental well-being of young America. It would start youths through life with the glowing health and the self-disciplined character that mark a typical Army man—and a successful civilian. Comment among service men, legislators, doctors, and educators, enthusiastically backs him up. A tentative plan calls for a year of military training after graduation from high school, to be *(Continued on page 240)*



BOMBS VS. FUEL. While existing bombers could fly the Atlantic and return without landing, fuel requirements for such a trip cut the possible bomb load to little or nothing. However, big superbombers of the future may put America within easy bombing range of an enemy on another continent

Repair-Yard Miracles Save Torpedoed Ships

By VOLTA TORREY

FOR guns and shells, vehicles and fuel, food and clothing, our Armies overseas depend on a great chain of ships. An infantry division can shoot off 542 tons of ammunition in one day. An armored division can consume 78,000 pounds of food in the same period of time. In a single hour a mechanized division can use up 18,000 gallons of gasoline

Every link in the enormous chain required to carry supplies to men fighting a two-ocean war is precious. The loss of a single freighter or tanker can be like the loss of a horseshoe nail for want of which a horse was lost, a rider was lost, a battle was lost, and a kingdom fell. A ship, moreover, can be knocked out in many ways—by rocks, by collisions, by gales, by mines, by bombs by shells, or by torpedoes.

But ships that seemed as irreparably damaged as Humpty Dumpty have been restored to service on the 56,000-mile sea routes of the United Nations by the heroism of their crews, the skill of salvagers, and the ingenuity of engineers. Enough vessels to comprise a great merchant fleet have limped into the big ship hospitals on both U. S. coasts, with long rips in their bellies, huge holes in their sides, and even whole sections missing—and then emerged a little later as seaworthy as ever. Even ships that the enemy succeeded in blowing in two have been enabled to resume their war work by miracles of ship surgery

One dark night off the Carolina coast, the two-year-old tanker *Esso Nashville* leaped from the water and fell on her side. A German submarine had torpedoed her. Capt Edward V. Peters fell into the sea when he slid down the pilot's ladder toward a lifeboat. Lest the boat be smashed against the ship's side, he ordered it pulled away without him. The wind and sea soon carried it too far off to return for him. The captain's leg was fractured and his chest was injured, but he floated himself back onto the tanker's sagging deck. Painfully, he made his way aft to the engineers' quarters, bandaged his leg, and then hoisted the ship's ensign upside down as a distress signal

By morning, the whole forward section of his ship had broken off and vanished But three naval vessels sighted the floating wreckage. The captain went overboard again and was rescued

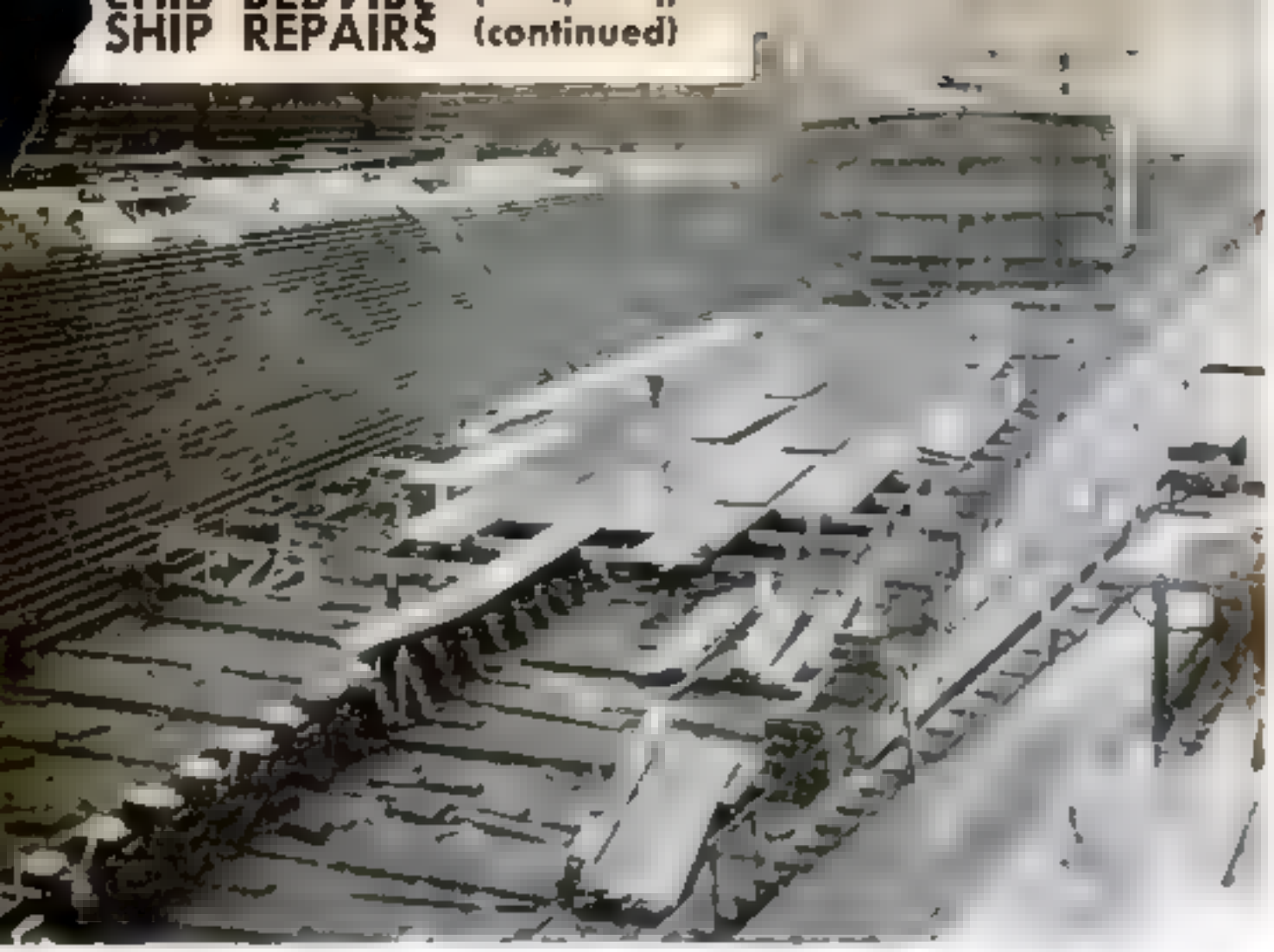
Now the *Nashville* is back in service. The stern section of the vessel, containing the propulsion machinery and its auxiliary equipment, was boarded by salvagers and repaired enough to keep it afloat. This bat-

Hit below the belt by two Nazi torpedoes, this rugged British ship refused to go down. When the crew who had hastily abandoned her, saw that she was going to stay afloat, they reboarded her, turned her bow toward New York, and ran her straight into the yards of the Todd Shipyards Corp. There unbelieving salvagers found this tremendous wound in her side. By putting more than a million and a half pounds of material into her, however, workers had her back in service in record time

Feed Our Fighters at the Front

Photo from Ships

Coming in on a stern and a prayer ships even more badly battered than this one (which appears to have been the victim of a crushing one-two punch from a Nazi bomber and submarine) have been known by some miracle not only to make port but after a bit of naval surgery to have gone steaming out to the fight again as seaworthy as ever. By comparison with others that might have limped home this ship was only moderately wounded



A TANKER

1 The stern end of the *Nashville* is all that remained of her after a German torpedo had cracked her in two off the Carolina coast. Containing only her propulsion machinery and auxiliary equipment, this end was towed back to the site of her launching—the Sparrows Point Yard of the Bethlehem Steel Company, at Baltimore—where she was floated into this graving dock

tered relic was towed to the Bethlehem Steel Company yards near Baltimore, where the ship had been built. Divers descended and trimmed off enough of the jagged, twisted plates to permit the salvaged section to enter a dry dock. Big prefabricated parts were swung into the dock with cranes, and a whole new forward section was built and added to the fraction of the ship that had been saved. The *Nashville* was rechristened by the same lady who had cracked the champagne bottle that launched the vessel the first time, and sent back to sea.

Another reborn tanker is the *E. H. Blum*. She was severed by a torpedo, and several men perished in their haste to abandon her. The after section sank, but the forward part remained afloat and was towed to Norfolk, Va. Salvagers then went out and lifted the 300-foot after section out of Davy Jones's locker, took it into port, and put the *Blum* together again.

Modern methods of building ships have made such feats possible. Each cargo hold is partitioned off from the others by a watertight bulkhead. A collision bulkhead walls off the bow, and an after-peak bulkhead forms a rear guard against damage to the whole ship. Each section has sufficient buoyancy to float by itself. And the partitions are so sturdy that even high-octane gasoline in one section of a tanker sometimes has been undisturbed by fires and explosions destroying other sections.

But courageous and able seamanship also accounts for the survival of many crippled vessels. In the Pacific, a torpedo punched a hole in the hull of the *W. S. Rheem* large enough for a locomotive to enter. Shifting cargo and using the port and starboard engines skillfully, Capt. G. A. Johnson went ahead and delivered his goods—including 535 of 850 iron barrels of lubricating oil that had been in a damaged hold—to the U. S. Navy. The *Rheem* then waddled home 550 miles for repairs.

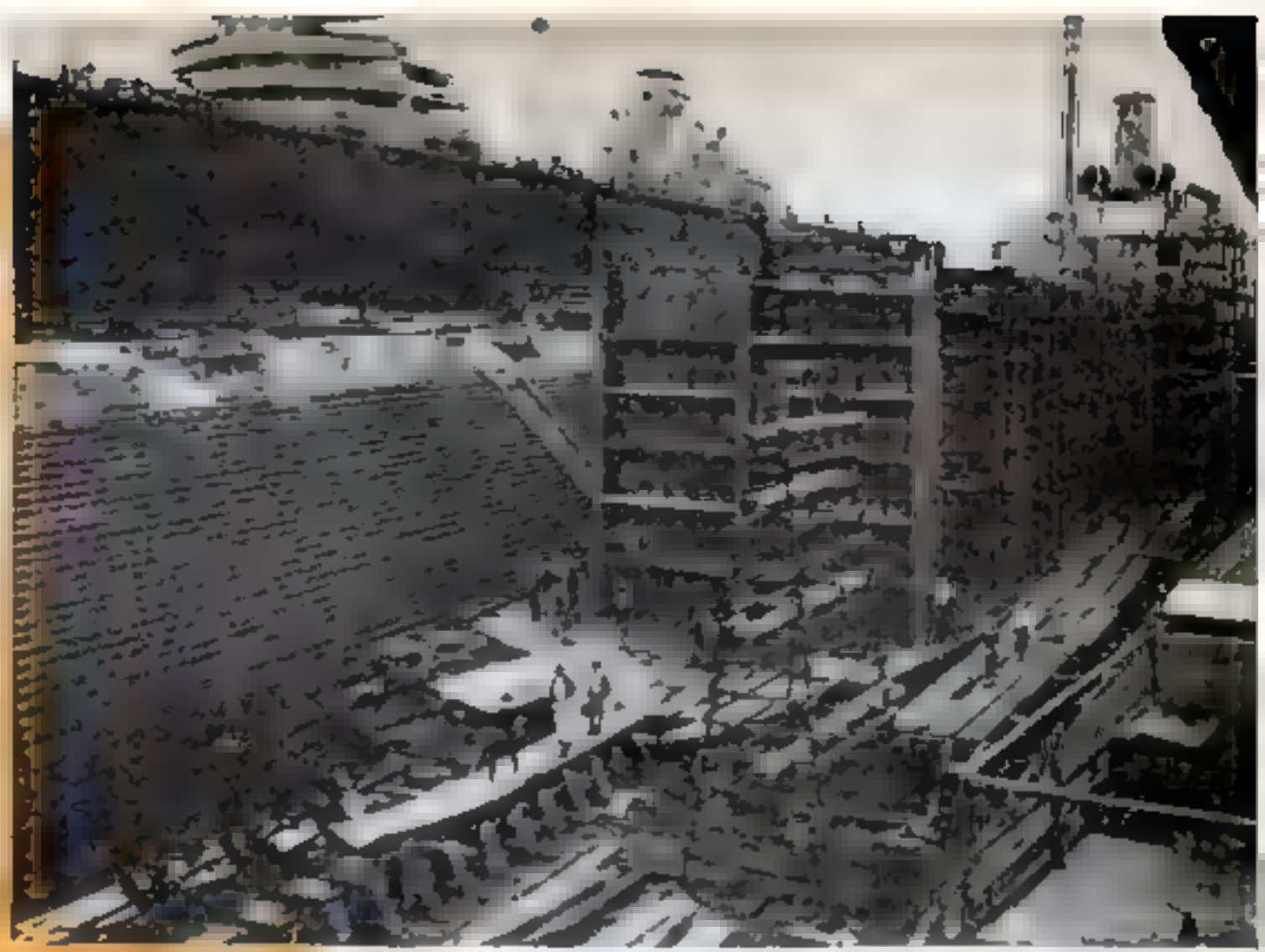
The big yards along the American coast are equipped to perform almost any kind of operation on a damaged ship. But amputations, substitutions, and other jobs often must be done in foreign ports with inadequate facilities and materials. Hence, a whole series of operations is sometimes necessary to make a ship as good as new.

The shallow-draft, lake-type tanker *Pedernales* was one of four ships torpedoed one night early in the war by a submarine that slithered in close to the big American refinery at Aruba, in the Dutch West Indies. The *Pedernales* was riding at anchor, loaded with crude oil and already covered with smoke from another burning ship, when she was hit smack in the middle.

"She folded up like an old shoe," says a Standard Oil official who heard her howl of pain. Her anchor let go and she drifted along the shore in flames. Several members of her crew were lost, but the tanker was saved.

Tugboats shoved her into shallow water. Her bow and stern protruded at sharp angles, while the sea ran over her ruptured

IS REBORN



2 This is how the *Nashville* looked a month after the work of reconstruction was begun. Prefabricated bulkheads, six to 12 tons in weight, were lightered to the dry dock and quickly put in place

3 Two thirds of her rebuilt, and rechristened by the same woman who first cracked a bottle over her bow, the *Nashville*, five months after she was towed home, is shown back in service for the Allies

midsection. Oil and water were pumped out of some of her tanks, and blown out of others with compressed air. The exposed parts of the plates holding her two ends together were cut away with acetylene torches. Then the salvagers dynamited the middle out of her. Divers did this by taking down small charges, placing them against the plates at carefully chosen points, and covering them with sandbags.

When severed, the ship's two ends righted themselves and floated uncertainly about a hundred feet apart. Leaving the debris of her midsection on the ocean's bed, tugs towed each end of the vessel to a marine railway about 20 miles away. Each end was run ashore on the tracks, trimmed and to within about two feet of a bulkhead, and allowed to slide back into the water.

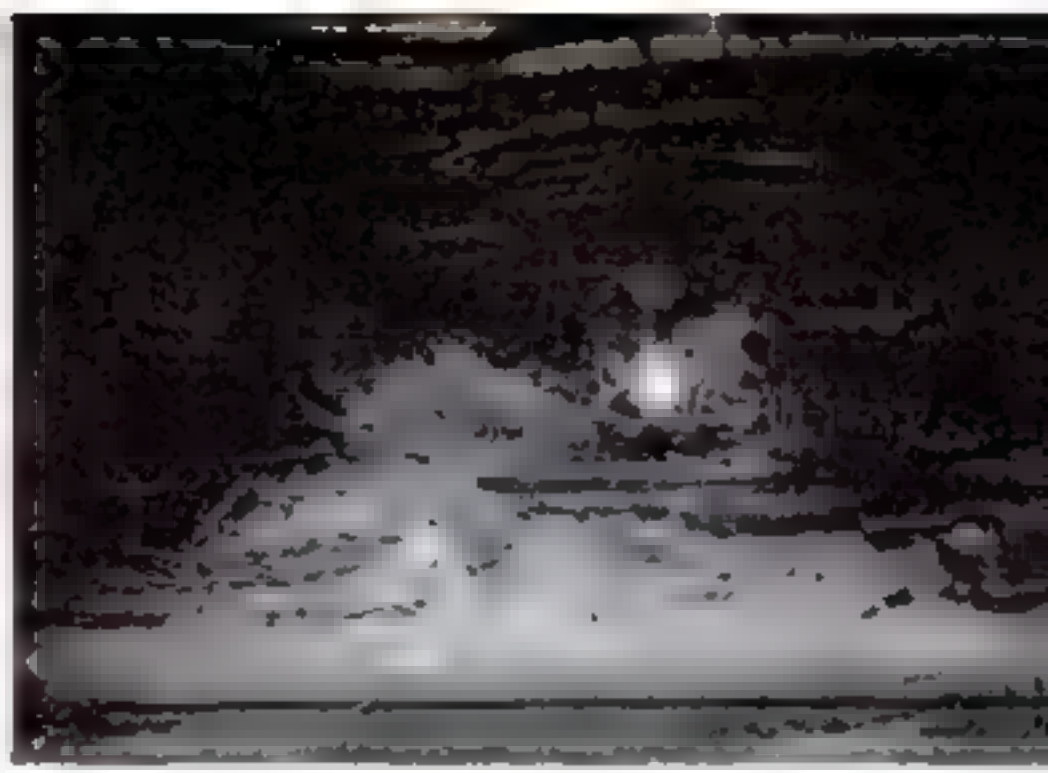
The tugs then maneuvered the after section into line with the forward section. This was like bringing the two ends of a broken bone together. They were lined up and temporarily attached with 12 by 14-inch timbers and 10-ton chain falls. Then the two parts were hauled up on the marine railway a second time, and steel plates were welded across the short gap left between them. But no effort was made to make those plates watertight, because the bulkhead walls would keep the sea out of the rest of the ship.

The *Pedernales* originally had been about 360 feet long. Without her midsection, she measured only about 110 feet.

The repair crew at Aruba built a temporary wooden pilot house on her to replace the burned-out superstructure, overhauled her engines, and launched her without ceremony. Capt. H. McCall and the surviving members of his crew sailed this "ship without a middle" to Baltimore under her own power.

There, in the meantime, a new midsection had been built for her. So the *Pedernales* was cut in two again. The new midsection was launched sidewise and floated in between the two ends. All three parts were

1 This view of the underside of the German built Norwegian tanker, the M. S. *Solfonn*, shows the cement debris that was dynamited out of her during the process of rebuilding her bottom, which was ripped to shreds when she slammed into the rocks off southwest Africa



2 Because of the cramped quarters, the only way to remove the debris was by wheelbarrow. At the Cape of Good Hope, where the *Solfonn* was originally taken for repairs, some 600 tons of cement were poured into her to patch her sievelike bottom

5 Here a few of the damaged plates have been removed. Suddenly freeing herself from the rocks at a moment when her skipper thought she was going to crack in two, the *Solfonn* was towed to the Cape, from where after preliminary repairs, she limped home to Baltimore

6 This is how the *Solfonn's* new underside looked by the time the ship surgeons were through fixing her up. Before she could be eased into the dry dock, however, divers had to go down and make sure her accident hadn't left any dangerous obstructions

then carefully lined up in a dry dock and welded together. Nine months after a submarine commander had reported that tanker knocked out, she went back to work.

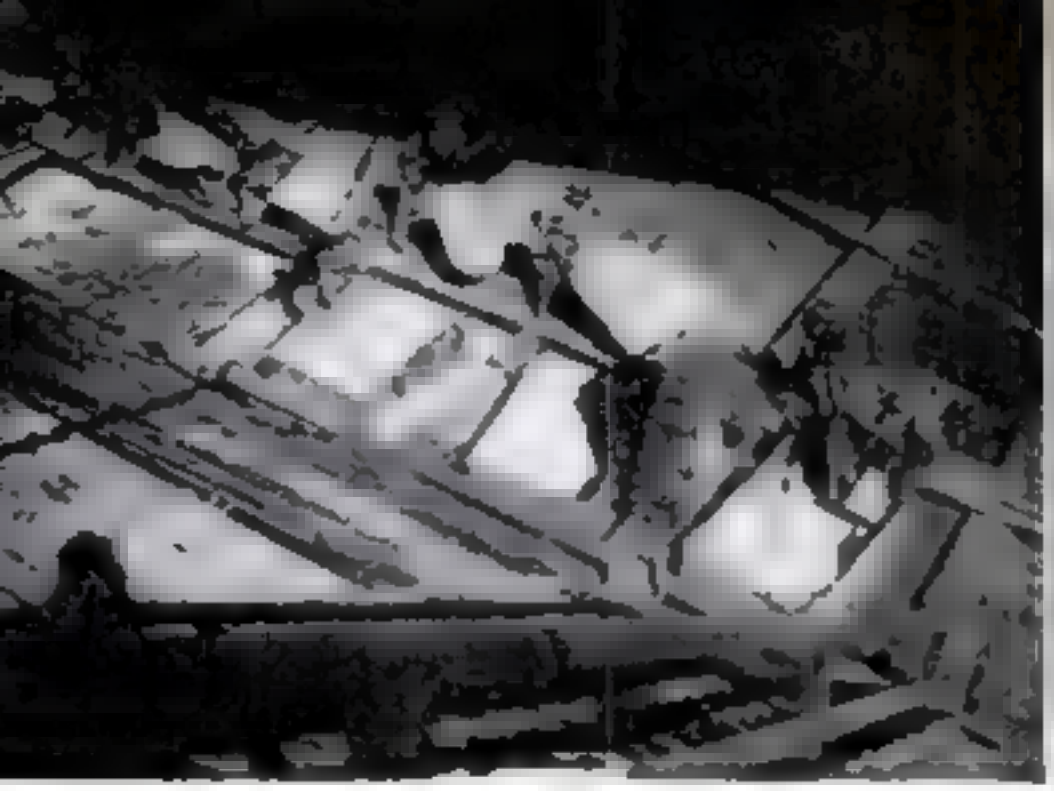
Another ship that came home looking like something out of a marine architect's nightmare was the Grace Line freighter *Santa Maria*. She had hit a mine.

Her captain, Robert J. Twaddell, a veteran of 15 years at sea although only 31 years old, was knocked out by the explosion. When revived by a geyser of water that sprayed the bridge, he looked out and saw that 80 feet of the bow of his ship had disappeared.

The headless *Maria* was tossing like a rocking horse. Two ponton hatches were impaled on the antiaircraft guns on the flying bridge. Sisal from the forward hold had been thrown over the fore and main trucks to the poop deck. The forward gun and the two men tending it had vanished. One man was fished out of the sea later, the other was never found.

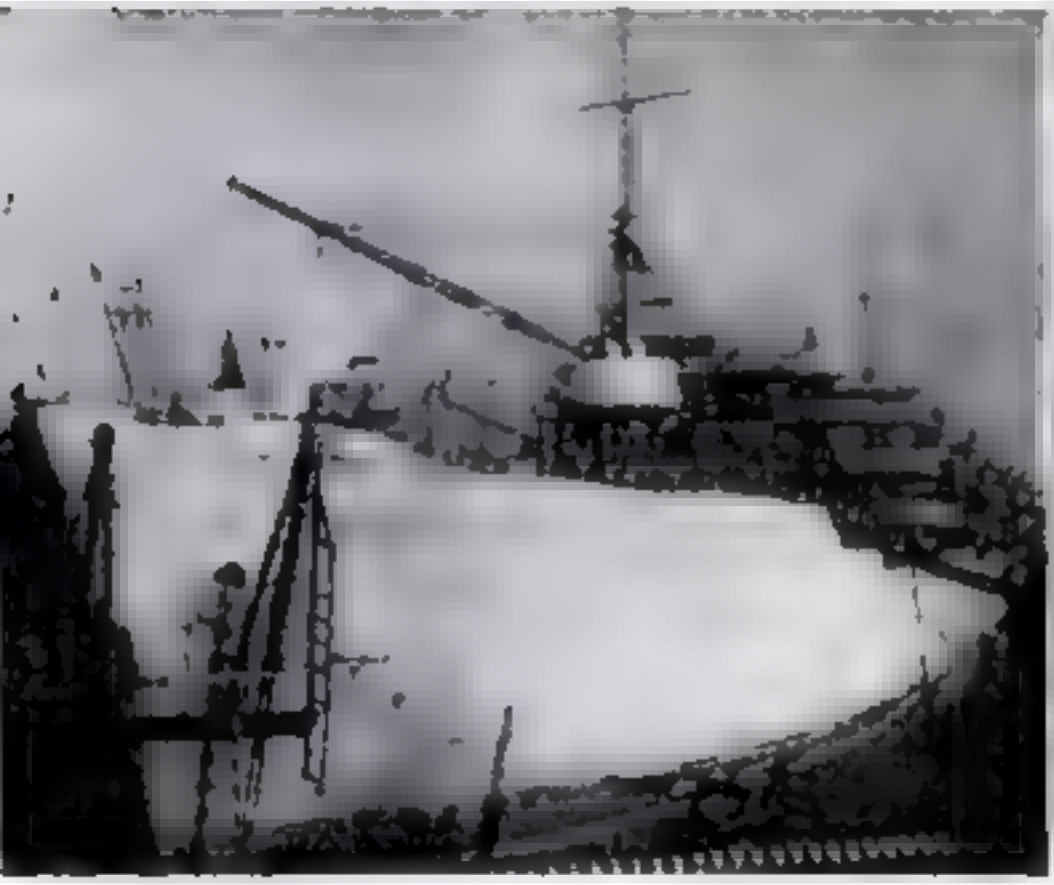
The ship's second hold remained watertight. Water ballast in its deep tanks diverted the explosion's force upward. The chief engineer shut off the electricity, which was short-circuiting everywhere, in time to prevent a fire. And young Captain Twaddell got his decapitated freighter into an African port.

The only steel he could obtain there to patch his vessel with was in the form of a



3 To speed the work of removal, the concrete was dumped from the wheelbarrows into these conveyors. The final repair work, shown in the photos on these pages, was done in a 20,000-ton floating dry dock at the Baltimore yards of Bethlehem Steel Corp.

4 When the *Solfonn* went aground she hit so hard that her captain, who was tossed out of bed, thought she had been torpedoed. Tugs from the mainland came out and tried unsuccessfully to pull her free. Some of the damage to her inner-bottom construction is revealed above



7 The tanker as she appeared on the "operating table." One of the most difficult parts of the job was the blasting, partly because of the necessity of keeping her evenly at rest on keel blocks. If she had toppled, she would have wrecked the dock

Photos from Bethlehem Steel Corp.

8 The tanker as she was towed from the graving dock to the outfitting pier. To make a new woman of her, 1,000,000 pounds of steel plating and 1,500,000 pounds of internal steel were used. Salvagers call her the biggest repair job ever done in an East Coast shipyard

cofferdam that had been used to fix up a French battleship. With the help of three French naval officers, Captain Twaddell got that cofferdam converted into a new bow for his ship. To make it fit snugly, 20 feet of twisted wreckage had to be cut off the *Maria*. But even then there was the problem of how to attach this 56-ton makeshift bow without the use of a dry dock.

The keel of the *Maria's* stubby forepart was tilted to within four inches of the surface of the water by shifting as much weight aft as possible. Members of the crew stood on the stern to help. The crude bow then was swung into place by a floating derrick and partly attached. Finally, the forward end of the ship was raised a few more inches with the derrick's help and the bottom plates were connected.

After a test run, the *Maria* crossed the Atlantic under her own power at an average speed of more than 11 knots.

The *Nashville*, the *Blum*, the *Rheem*, the *Pedernales* and the *Maria* are but a few of the hundreds of crippled vessels that seamen and ship surgeons have restored to the all-important job of keeping supplies moving swiftly to the fighting forces of the United Nations. It is impossible to list them all. But there's one more gallant old girl whose story can and should be told. She's a Norwegian tanker, built in Germany, and christened M. S. *Solfonn*—which means "Sun Glacier," or "Snow *(Continued on page 227)*

What About Postwar

It Can—and Should—Go Places, but in the Meantime There Are a Lot of Troublesome "Ifs." Sound Broadcast Reception, on the Other Hand, Is Due for Immediate and Vast Improvement

PART II OF A SERIES ON ELECTRONICS AFTER THE WAR

YOU probably think, as does almost every one else, that you will have a television set in your home soon after the end of the war which will be a combination theater, baseball field, football gridiron, movie screen, animated newspaper, concert stage, and all entertainment rolled into one. You may be wrong.

The cold fact is that television, much as it has been publicized, has actually been a commercial failure. And it may well be a disappointment for years to come if we don't use our new war-born knowledge of electronics to provide a projection-type receiver selling for not more than $200, a larger image, better definition and greater brilliance, and possibly color, too.

Carl Dreber throws light on these problems in this authoritative forecast, and discusses as well the future of FM (frequency modulation) in sound broadcasting. He was one of the early radio amateurs, subsequently a radiotelegraph operator and engineer, then engineer-in-charge of WJZ and the first RCA broadcast network, chief engineer of RCA Photophone, and director of recording for RKO Studios. He has been a frequent contributor to POPULAR SCIENCE MONTHLY.

By CARL DREHER

"ENTERTAINMENT is a serious thing," Dr. Alfred N. Goldsmith observed in the early days of broadcasting. He was right: entertainment has remained the most important function of the mass communication services. It is important to instruct people, but in a nervous and complex civilization like ours it is even more important to amuse and thrill them. Of course the one by no means excludes the other; actually a medium like radio teaches best when it interests and intrigues the audience. What, then, is the future role of electronics in providing entertainment in this broad sense?

Television has been called a casualty of the war. The truth is that it was a casualty of peacetime. It had no job. It was a commercial failure.

It was the war that gave television, or the people employed in ingenious but unsuccessful efforts to make it into an industry, something important to do. Television provided skilled personnel as a nucleus for the development, manufacture, and operation of vital electronic equipment for the Army and Navy. It was no small contribution—and it may turn out to be bread cast upon the waters. There is every reason to expect that after the war the armed services and the war industries will repay their debt in the form of improved, simplified, less expensive equipment, and that in consequence television will achieve the mass acceptance and economic success which previously eluded it.

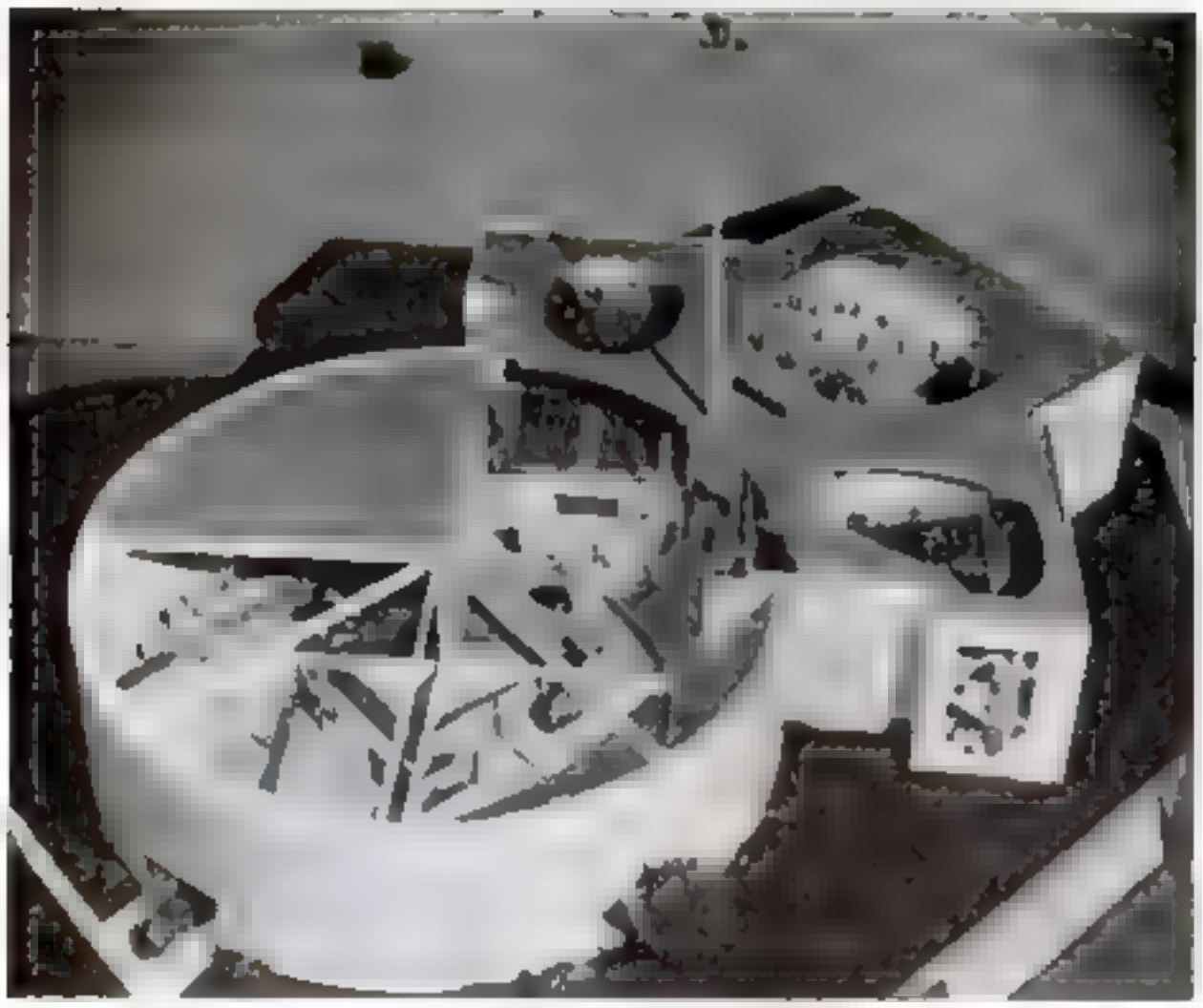
Prewar television was a commercial flop primarily because it was not good enough technically, and in consequence did not offer enough for what it cost. The image was too small. It was not clear enough. Those who were actually trying to make television into a medium of entertainment, as distinguished from those who were writing the ballyhoo for it, know that it was virtually limited to close-ups even in the studio, and that the actors were not recognizable in the average two or three-shot, with the camera cutting them off at the waistline.

Outdoors it could pick up objects only under the most favorable light conditions, and here again the smallness of the picture made full shots little more than a challenge to the spectator's imagination and an appeal to his forbearance. Too frequently, also, there were transmission troubles and

Television

TELECASTING a scene from a modern studio calls for the closest co-ordination between performers, technicians, and directors. On the set cameramen and director get orders by earphones from the program director, who watches pictures picked up by the cameras and switches close-ups, long shots, or filmed scenes onto the air. Unlike a movie, which can be patched together from shots taken at different times, the television program has to be assembled from several cameras scanning long and short shots, filmed material, and titles while the action is going on

Photo from CBS



The postwar television studio will look something like this, according to engineers of the Austin Company. Heart of the design is the large turntable stage, with an auditorium for visitors attending the shows

interference, much more irritating to the eye than equivalent defects in sound broadcasting are to the ear.

What the prewar era did accomplish was to establish television on a firm electronic basis, with the iconoscope and other all-electronic devices used for pickup, and the kinescope for reception. What postwar television will need is a projection-type receiver based on these or more advanced electronic principles, in which the picture will be thrown on a screen at least 12 by 16 inches and preferably 18 by 24 or larger, with definition, brilliance, and contrast equal to the best 16-mm. movies or better, free from interference 95 percent of the time, and selling in the $200 range.

If electronic technique can provide such a receiver, together with pickup improvements which will allow full utilization of its performance characteristics, then television will be going places. Then, indeed, it will have a mass market capable of putting a dent in an incipient depression, or helping proportionately to maintain a high general level of economic activity.

Conversely, until we are in a position to give the customers their money's worth, we had better not venture out on the limb again.

Is equipment of this quality going to be available at around $200? I have no inside dope, but I do have confidence in electronic research. Before the war we were pretty niggardly in spending money for research. Of course we talked as if we were turning our pockets inside out, but our actual annual outlay for industrial research was about $200,000,000 a year, or between 10 and 15 percent of what we spend for cigarettes. The war raised this figure substantially, and, by reason of the importance of radio in military and naval operations, much of the money was channeled into electronic investigation. With civilian outlets tightly closed, the resulting developments are piling up behind a dam of military necessity and secrecy, and are largely segregated even from one another. With the end of the war the dam will be breached. First a trickle, then a flood, of civilian applications will pour forth.

Capable of "Telecasting" Anything That Can Be Seen and Heard,

Photographs below, courtesy of General Electric

DRAMA . . .

SPORTS . . .

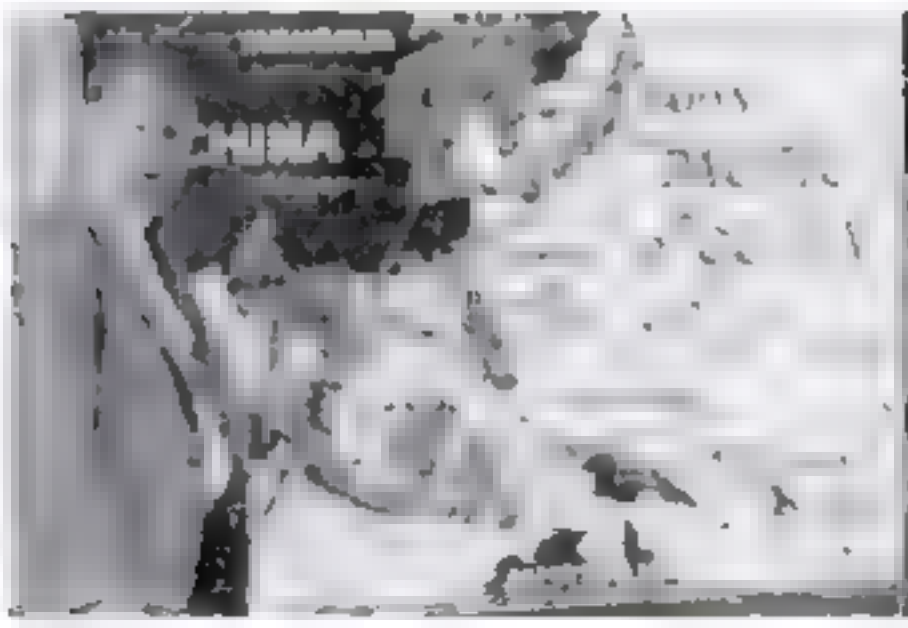
Clear, large-screen reception is a "must." In this RCA developmental job, the kinescope image is projected onto a mirror that reflects it onto the back of the translucent 13½ by 18-inch screen. The screen is retractable

Television will hardly remain unaffected; thus war developments may help to solve the correlated problems of brilliance, definition, and size of image. Perhaps they are already well on the way to solution. In May of this year, RCA engineers announced that they had a model of a $200 postwar television receiver capable of producing an 18 by 24-inch picture through a highly efficient optical system of molded plastic lenses. With a de luxe attachment a six by six-foot picture could be projected in the home. In both cases brilliance and definition were said to be greatly improved over prewar standards. Another reported advance was a more sensitive television camera, capable of picking up outdoor events under adverse light conditions, and materially reducing lighting requirements for studio pickup. The General Electric Company was working along similar lines. Thomas Joyce, manager of RCA's television sales department, predicted the marketing of some 750,000 home receivers within 18 months after the war.

A basic requirement for the economic health of television is syndication or network distribution of programs. Television outlet stations, like all radio transmitters using quasi-optical waves, have a range limited approximately to the optical horizon. That means you can transmit reliably only about as far as you can see under the best conditions from the transmitting aerial, or at most, 60 miles. The outlet stations must therefore be interconnected to reduce the total cost of programs, which is going to be extremely high, to a low cost per unit of audience. A $50,000 program, distributed to 5,000,000 spectators, costs only one cent per spectator. This is mass distribution applied to entertainment.

When sound broadcasting came into being, network interconnection facilities were already in existence, since the telephone had been invented over 40 years earlier. For picture broadcasting, equivalent facilities must be created. The coaxial cable and waveguide transmission lines are, as we saw in the preceding article, already in an advanced state of development. An alternative

Television Promises to Bring the World into Our Living Rooms



NEWS . . .

OPERA . . .

method is automatic, low-power radio relaying, which is also past the early experimental stages. The relay stations, using extremely short waves, will be individually limited in range, the same as the outlet stations, but a chain of 120 or so, equipped with highly directive receiving and transmitting antennas, would carry a television program across the continent.

Television network connections are going to be expensive. Just to make a guess at the cost, let us assume that special cables for television will cost $10,000 mile, which happens to be the actual cost per mile of the first coaxial cable installed for regular commercial service, between Minneapolis, Minn., and Stevens Point, Wis., in 1941. At that rate, a transcontinental cable would entail an expenditure of $30,000,000, not all of which would be legitimately chargeable to television, since it could carry other services as well. However, to be conservative, we will load the whole capitalization onto television. Ten such lines, interconnecting the principal outlet stations all over the United States, would then represent an investment of $300,000,000. Or assume 10 lines of 120 radio relay stations apiece, each line spanning 3,000 miles and each of the 1,200 stations costing $60,000: that would add up to $72,000,000.

These guesses may be too low. Very well; let's shoot the works and assume that television interconnection will call for an initial investme t of a round billion dollars. That is real money, but it is still only one percent of what we are spending every year on the war, without the slightest hope of getting much of it back. A billion dollars, spread over twenty million receivers, comes down to an investment of $50 per receiver. Say $100 dollars per receiver for the whole works—studios, outlet stations, everything. That debt can certainly be serviced and amortized by an industry which can easily do a billion dollars' worth of business a year.

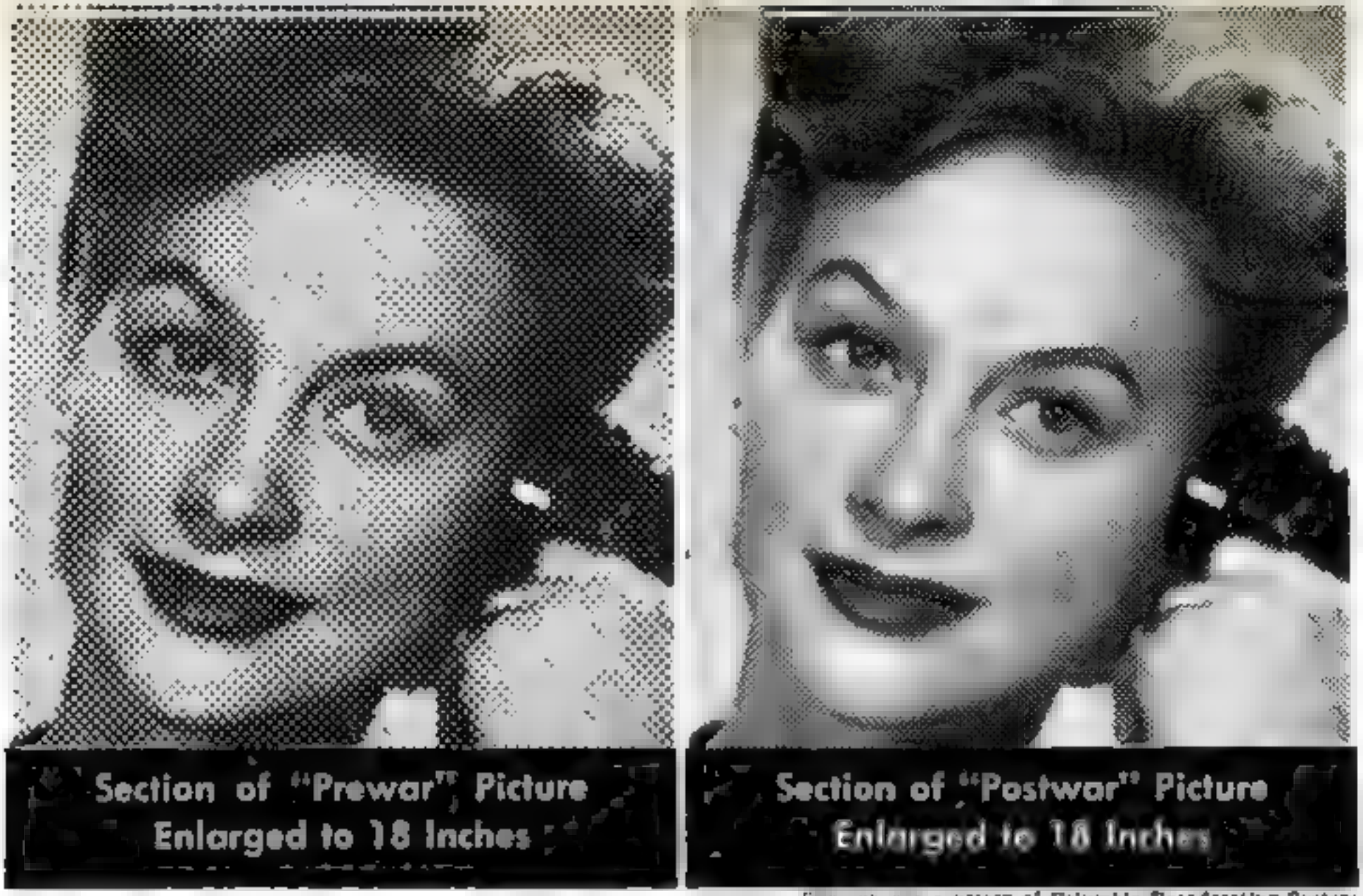
Television is going to be big or it isn't going to be at all. The decision as to whether we are going to have it will not rest with electronic engineers; they can only provide the means. Electronics can serve us fully only if we are a bold and energetic people. By nineteenth-century standards, even by prewar twentieth-century standards, the economics of television are on a staggering scale. But not by postwar standards, provided we are prepared really to take advantage of our technological skills and productive capacity to pay the bills for mass distribution of what used to be regarded as luxury products. Television is one of these

The benefits it promises are on the same scale as the costs. Take education. The little red schoolhouse, with its one classroom, has great romantic appeal, but it was really a very bad plant for teaching Most of our rural schools, and many of the urban ones, still are. And as often as not the teacher is no better than the plant. The efforts of the average teacher might well be supplemented with television lectures on special subjects

Range of television transmitters is limited to the visible horizon. Hence they seek the high spots, like this station of California's Don Lee System

Pioneer Television Network

A preview of nationwide video hookups may be seen in the New York-Schenectady link established by General Electric and in operation for three years



Photographs courtesy of Columbia Broadcasting System

Enlarging the prewar television picture to 18 inches would give a coarse image approximated by the halftone at left, above. Improved definition, as at the right, is a requisite for successful postwar operation

by the few great teachers of each generation. That holds not only for the elementary and high-school grades, but for much university teaching as well. Think of the tremendous service television can render to advanced study in medicine and engineering, for example.

On the straight entertainment side radio needs television as the silent movie needed sound. Audio broadcasting is all right for background music and the like, when people want to do something with their hands and can lend the radio only their ears, but it is a feeble medium for plays and spectacles. The characters in a televisionless radio play have to describe everything that is happening. When somebody pulls a gun he has to say, "Do you see this gun?" or somebody else has to say, "Don't point that gun at me!" We will not have to put up with such clumsy devices once television is available for dramatic presentations.

Television will come: we need it, culturally and economically. But it will not come the day after the Nazis and Nips call it quits. It may be a year after approval of standards and authorization for full commercialization by the Federal Communications Commission before it really gets under way. War industry may furnish the techniques, but they will have to be adapted to new uses. The transition from military to civilian production alone may take six months or more. Remember how long it took in the other direction? Plants will have to tool up, *(Continued on page 228)*

Linking New York and Schenectady, N. Y., Uses a Relay Station

Programs transmitted from the Empire State Building, 129 miles away, are picked up by an antenna system mounted on four 128-foot towers at the relay station. A special receiver-transmitter relays them to the WRGB transmitter for broadcasts to the Schenectady audience. Programs of local origin are also telecast

Redrawn from original by General Electric

Light, easily handled, conveniently carried, the M-1 .30 caliber carbine is semiautomatic and fires 15 shots as fast as you can pull the trigger. It takes the place of the .45 caliber pistol, and has a much longer range

How would you like to own a .30 caliber carbine? Light, sweet-handling, fast-shooting, and amazingly accurate—no wonder it has become

America's Favorite Gun

BY GOLD V. SANDERS

THAT neat little carbine so many thousands of our soldiers are using—yes and Marines and Seabees, too—has won a place in the hearts of men that military weapons rarely achieve (P.S.M., June '42, p. 79; Jan. '43, p. 124). The .30 M-1 has become a personal thing with the service men because of its sweet-handling qualities, its lightness, and its gentle recoil. Not that any he-man minds a healthy kick from a powerful gun —sometimes he actually takes pride in it— but there is something nice about a gun that delivers the goods through the muzzle without delivering a corresponding punch to your shoulder. This is what the .30 carbine does. Its gas-operated reloading mechanism

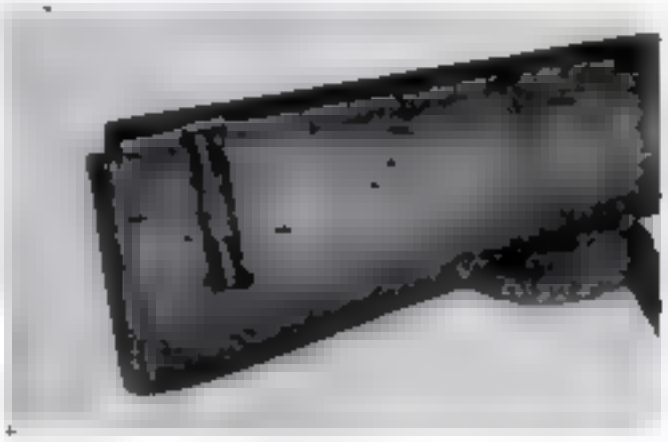
softens the kick down to something like a caress and leaves you still balanced for the next shot. There is little of the "creeping" characteristic of automatic guns under rapid fire.

Reports are constantly coming back from the fronts as to the fondness of our service men for this new war weapon. A lot of men are saying that they want to own this gun after the war, for sports use.

You need only to pick it up, handle it, aim it, and shoot it to understand why this is so. It has balance and personality. It is the sort of gun you will pick up often during the closed season to aim at imaginary game running along the picture molding. You will find yourself cleaning it when it doesn't need cleaning, oiling it when it needs no oil —just because it's a sweet thing to have in your hands. It comes up to the shoulder as if it belonged there, and it lines up your imaginary game in its sights so easily and naturally that you just know you can't miss with it.

The .30 carbine is proving itself every day in deadly combat as a great weapon for the purposes for which it was designed. It takes the place of the time-honored .45 automatic pistol for officers, engineers, Signal Corps and quartermaster troops, and it is the standard weapon of Rangers and paratroopers. It is far superior to the pistol as a defensive weapon, and is a real offensive weapon at ranges up to 300 yards.

Lt. Gerry Kisters, of Bloomfield, Ind., is one of the many soldiers who could tell a

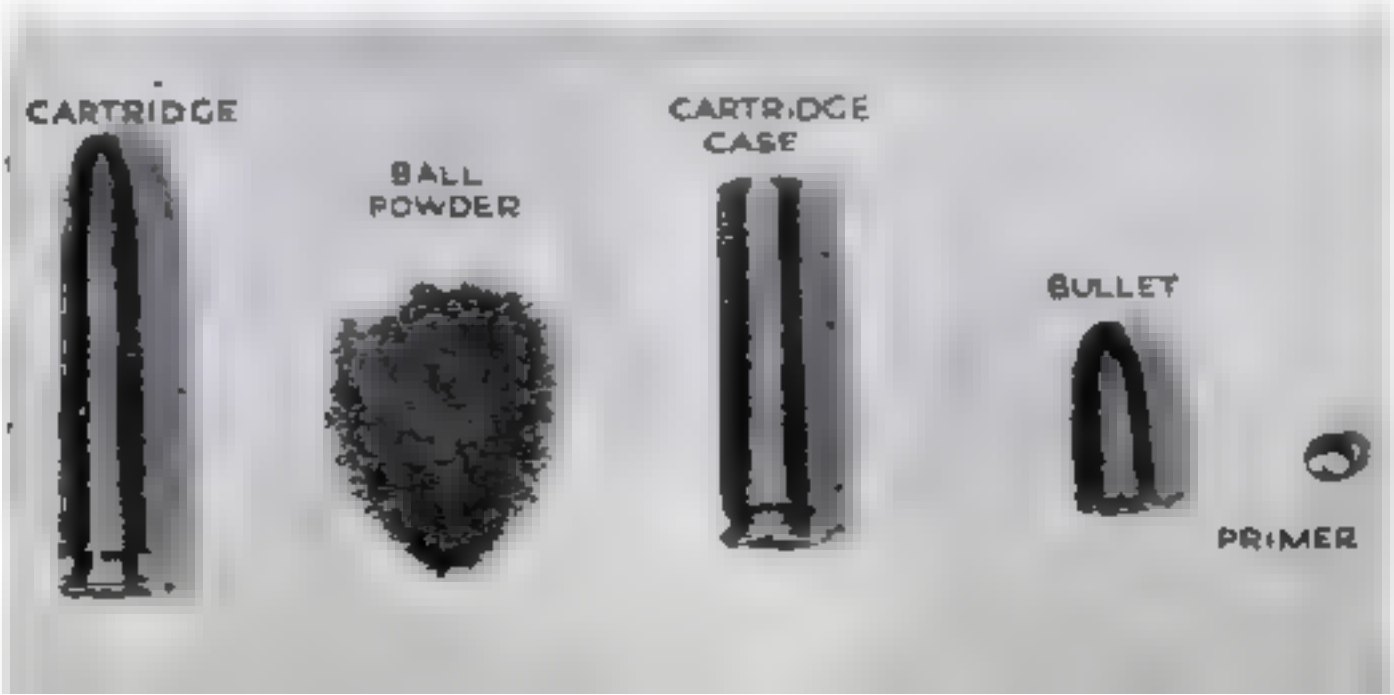


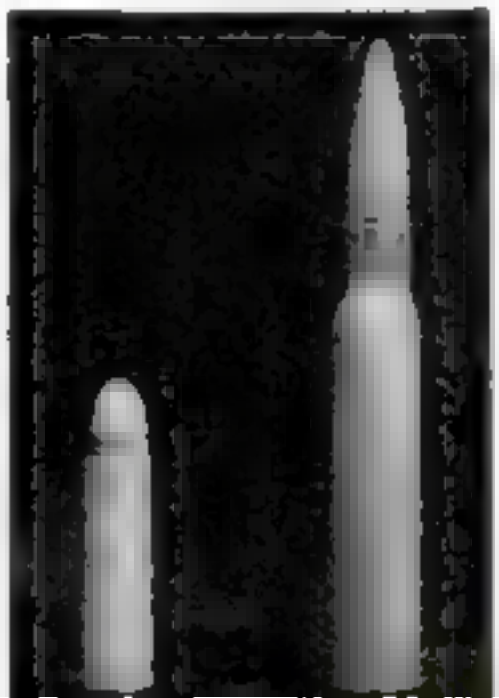
Fitted in a slot at the butt of the stock is a lubricating-oil can that doubles as the anchor for the sling by which the carbine is carried over the shoulder. Oilcan and sling are easily removed when it is necessary

The big shots like it, too. On a tour of inspection of American armored forces in England, General Eisenhower, Prime Minister Churchill, and Gen. Omar N. Bradley engaged in a friendly marksmanship contest. In the interest of Allied solidarity, results were not revealed

AMMUNITION IS LIGHT TO MATCH THE GUN ITSELF

One of the many advantages of this 5.5-lb., fast-shooting gun is its correspondingly light ammunition. The cartridge used, the component parts of which are shown below, weighs just one-half of that used in the .30 caliber Garand and Springfield rifles. There is a similar differential in size, as shown (lower right) by the picture of the carbine .30 caliber cartridge alongside the same caliber heavier shell

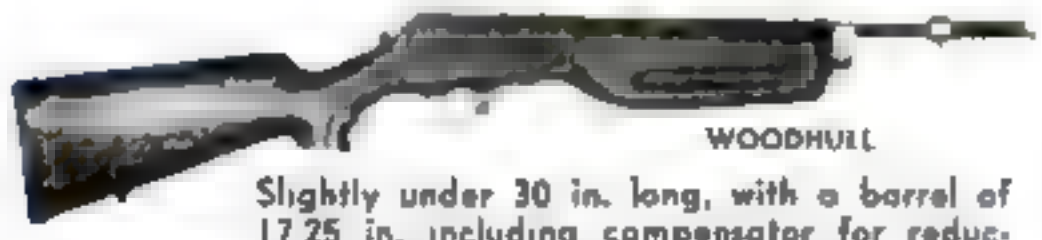




THESE WERE COMPETING MODELS

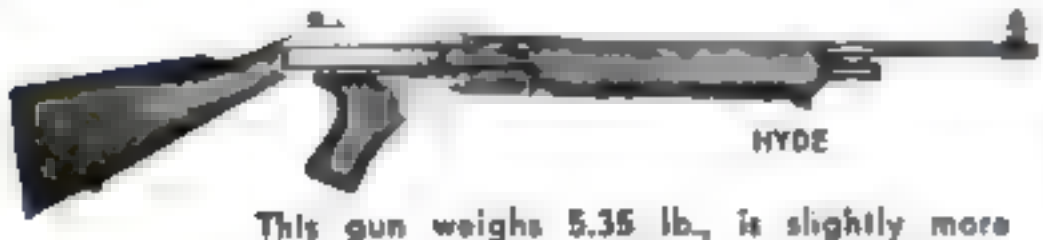
AUTO-ORDNANCE

This short-recoil type gun weighs 5.5 lb., is 35 in. long, with a barrel length of 15.6 in. Excellent accuracy at 100 and 300 yards. Its disadvantage is too many parts



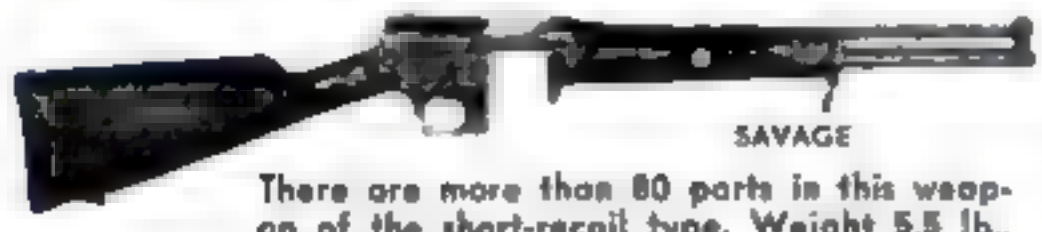
WOODHULL

Slightly under 30 in. long, with a barrel of 17.25 in. including compensator for reducing recoil, this gun has a straight blowback action. Weight of the gun is 5.5 lb.



HYDE

This gun weighs 5.35 lb., is slightly more than 33 in. long, with a barrel length of 15.75 in. It is operated by the gas intake 5.5 in. from muzzle. Accurate at 100 yards

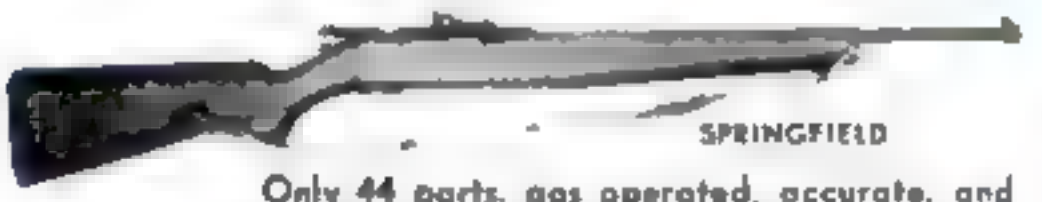


SAVAGE

There are more than 80 parts in this weapon of the short-recoil type. Weight 5.5 lb., length 33.375 in., barrel length 15.6 in. Accuracy is excellent at 100 and 300 yards

HARRINGTON & RICHARDSON

This is an adaptation of the H. & R. submachine gun. It has 48 parts and a simple action of delay-blowback type. Weight 5.8 lb., length 38 in., and barrel length 15 in.



SPRINGFIELD

Only 44 parts, gas operated, accurate, and weighing but 4.91 lb. Magazine, on the top leans 30 degrees to the right and the empty shells are ejected to the lower left side

lot about its effectiveness at close range. He is the only American soldier to win both the Medal of Honor and Distinguished Service Cross. It was in Sicily that he performed the heroic exploit of creeping up to within 30 feet of a German machine-gun nest, armed only with the deadly little carbine, while snipers poured lead into him. He was hit six times, three times in each leg as he crawled up a rocky slope. He kept right on, and when he could see the gun crew he started pouring some lead himself. He got three Nazis and the fourth one broke and ran; Kisters was just ready to drop that one, too, when the snipers got him in the right arm. That was the end of his shooting for that day, but he had won the Medal of Honor, to add to the Distinguished Service Cross for a similar act of bravery in Tunisia.

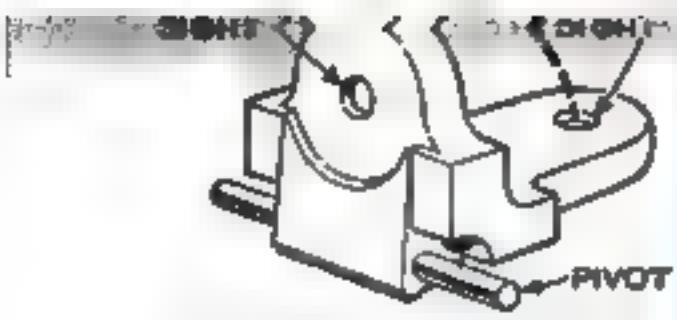
Just how many of the carbines are in service and how many will be, is not being told. But the gun is being turned out in large numbers, not only by Winchester, who created it, but by several other manufacturers. The same is true of its remarkable little cartridge, which was designed even before the gun itself

Whether the carbine will become a popular sporting gun

SIMPLE OPERATION

Directly below is the assembled .30 caliber M-1 carbine ready to shoot, while to the right is the gun in parts so far as it is allowed to be disassembled by the soldier in the field. Note the single retaining pin for the trigger-group assembly

The gun uses pressure of expanding gas to eject the empty shell and at the same time actuate a spring that chambers the next cartridge ready to fire



THE GARAND SIGHT

John C. Garand, inventor of the Garand rifle, designed this pivoted rear sight for use on the M-1 carbine, giving elevations for both 150 and 300 yd.

1 Removal of the one screw that holds the entire assembly together makes it easy to take the gun apart. Note the position of the Garand sight

after the war is a matter of considerable debate, and it depends largely on the kind of game you are talking about. For small and medium game, it is admittedly adequate, or will be when soft-nosed bullets are used in place of the jacketed military ammunition. When it comes to deer and larger game, the relatively light load and hitting power become a handicap as compared with those of the rifles now most popular for such game. At ranges of 300 yards and more, it lacks both the accuracy and the killing power of guns like the .30-30, the .30 '06 and the Remington .35. At 100 yards, the .30 carbine has just about half the hitting power of these guns.

One reason why the service men are so impressed with the gun is doubtless the fact that it pours out 15 shots from its box magazine as fast as you can pull the trigger. But true sportsmen frown upon this idea of throwing a lot of lead at game in the hope of making an occasional hit, instead of bringing it down dead with one well-aimed bullet. Furthermore, the use of this gun with its 15-cartridge magazine certainly will not be permitted by any of our state game commissions. It will have to be cut down to not *(Continued on page 221)*

2 A screw is loosened, a retaining spring depressed, and upper band slid off the stock. Then handguard is eased forward until fully disengaged

3 The barrel, receiver, operating slide, and trigger-group assembly are then removed for care and cleaning. It is unnecessary to use any force

AND FEW PARTS MAKE A RELIABLE FIELD WEAPON

How Noise Injures...

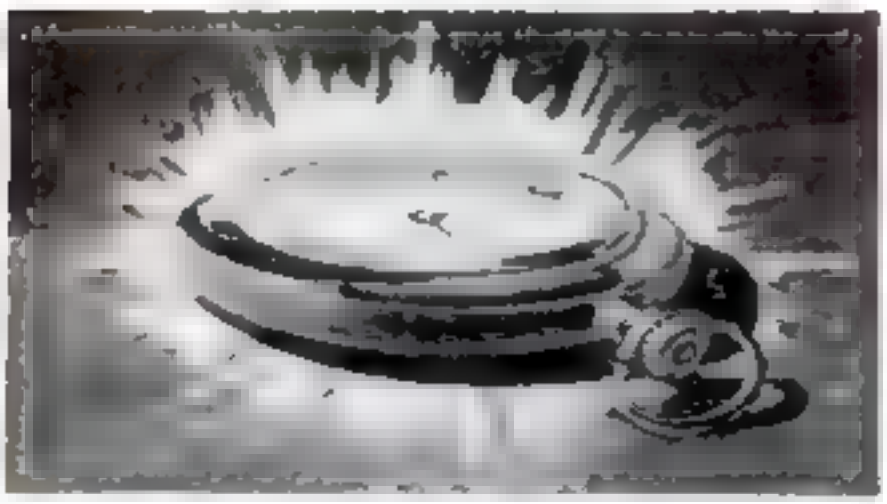
Unnecessary racket jangles our nerves, impairs our health, and cuts down our working efficiency. Here are some new slants on the abatement of this menace.

WHY not make clanging and pounding industrial machines silence themselves with their own din? The startling proposal, illustrated on the opposite page, highlights a report on ways to abate objectionable noises, recently presented by Dr. Carey P. McCord and John D. Goodell in *The Journal of the American Medical Association*

Many of the noises that jangle our nerves and impair our efficiency needn't be tolerated—and wouldn't be, if we realized the harm they do us. Practical suggestions contained in the report extend to everyday experiences at home and on the street.

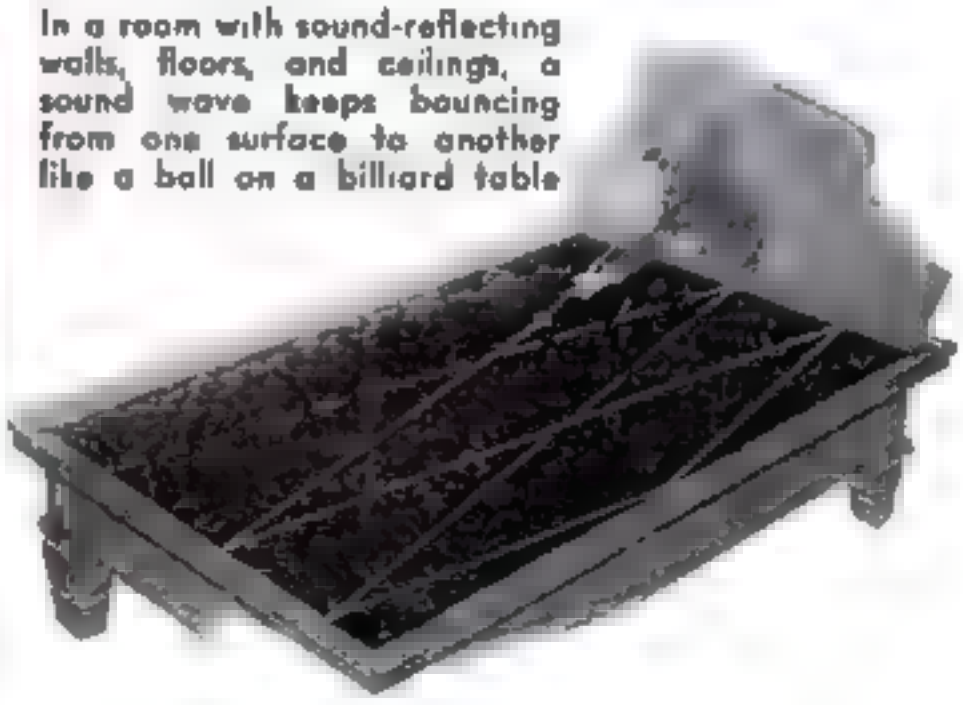
Traffic accidents have often been caused by loud-blasting auto horns that scare pedestrians out of their wits. At least one leading manufacturer is developing a horn that gives a soft but distinctive signal which will be just as effective for a danger signal.

An abrupt rise in noise intensity causes major discomfort. The average person can endure a continuous sound of 70 or 75 decibels, but a sharp jump from 40 to 70 decibels



Even the ticking of your watch, as it lies on a bedside table, can keep you awake. The table acts as a sounding board to amplify the noise. Try hanging the watch from a hook; the sound will be hushed

In a room with sound-reflecting walls, floors, and ceilings, a sound wave keeps bouncing from one surface to another like a ball on a billiard table

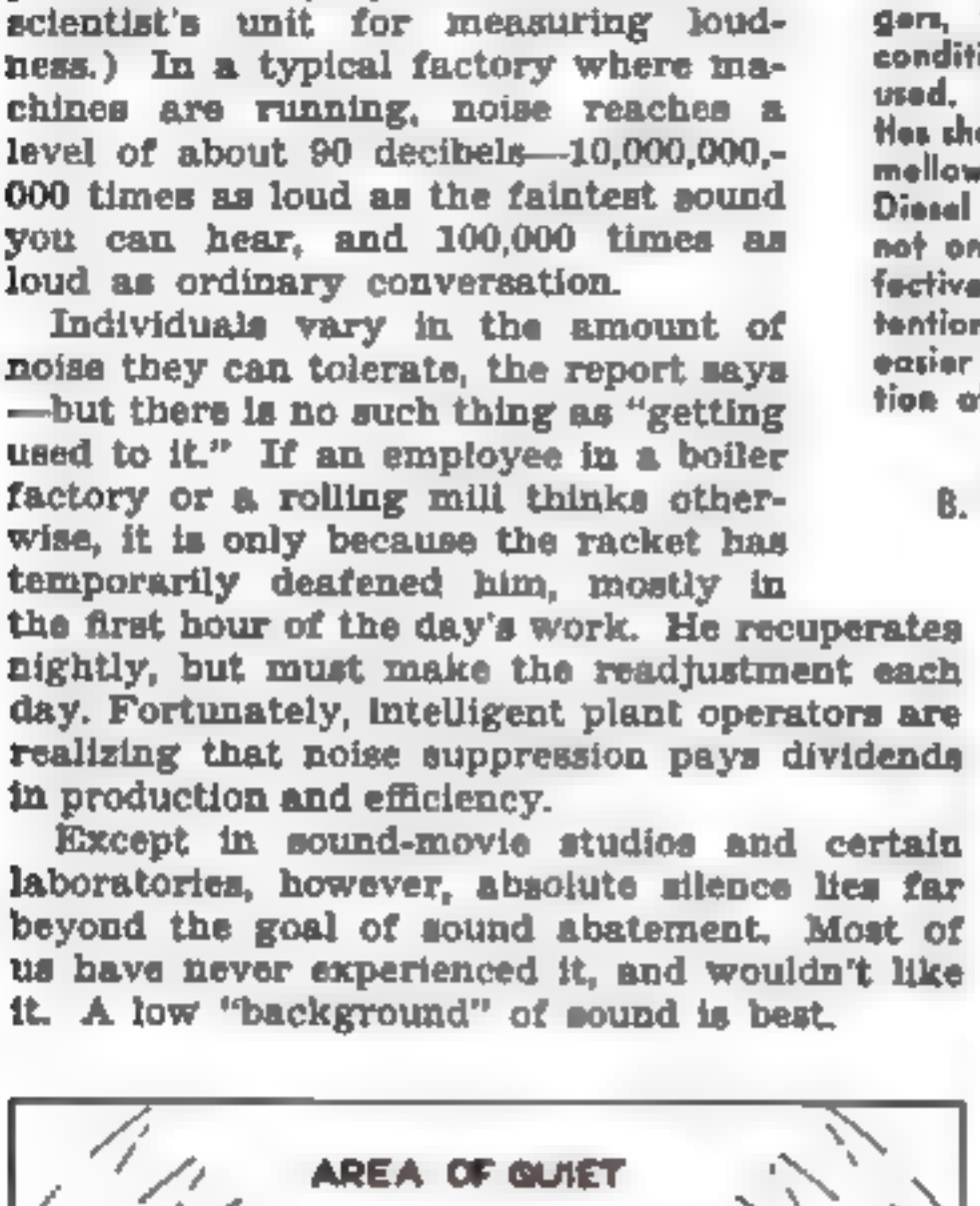


and What to Do About It

proves more trying. (The decibel is the scientist's unit for measuring loudness.) In a typical factory where machines are running, noise reaches a level of about 90 decibels—10,000,000,000 times as loud as the faintest sound you can hear, and 100,000 times as loud as ordinary conversation.

Individuals vary in the amount of noise they can tolerate, the report says—but there is no such thing as "getting used to it." If an employee in a boiler factory or a rolling mill thinks otherwise, it is only because the racket has temporarily deafened him, mostly in the first hour of the day's work. He recuperates nightly, but must make the readjustment each day. Fortunately, intelligent plant operators are realizing that noise suppression pays dividends in production and efficiency.

Except in sound-movie studios and certain laboratories, however, absolute silence lies far beyond the goal of sound abatement. Most of us have never experienced it, and wouldn't like it. A low "background" of sound is best.



Noise from a machine would be made to cancel itself out, in this startling new plan to reduce industrial fatigue. Loudspeakers would reproduce the objectionable sound at a carefully measured distance from the source, so that the crest of one sound wave would hit trough of another

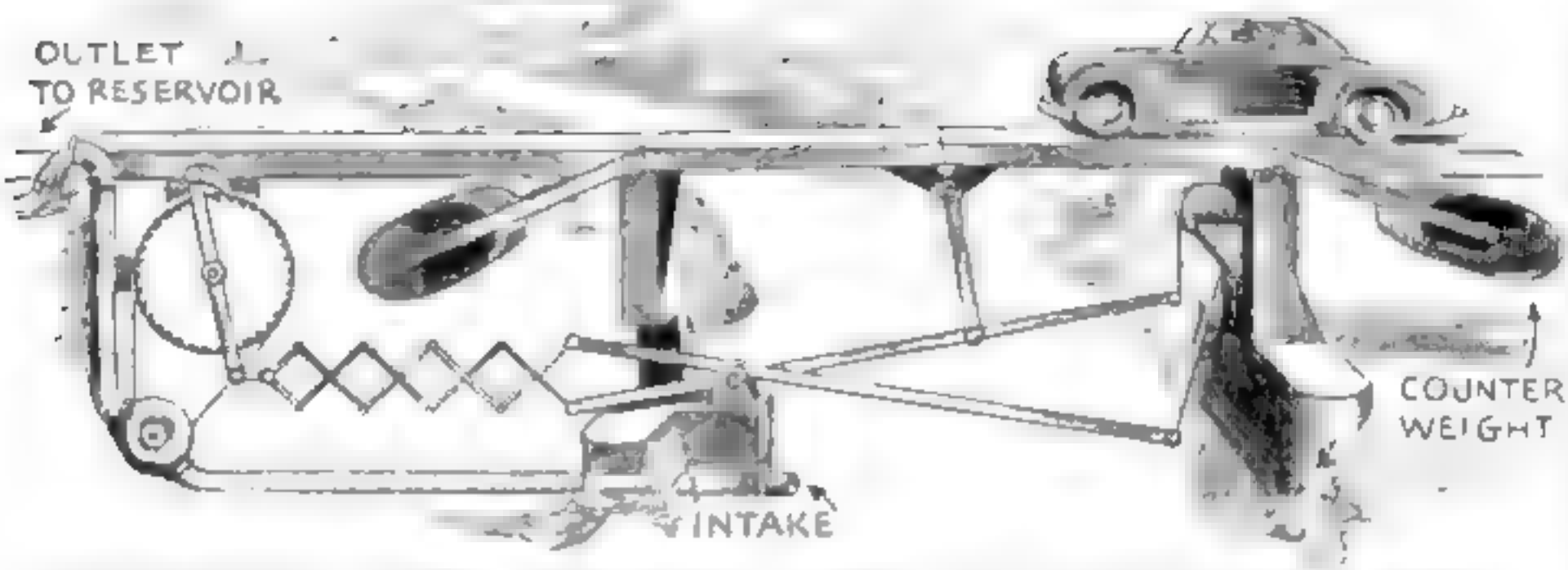
Train noises tire passengers, unless sealed, air-conditioned coaches are used. Shrill steam whistles should be replaced by mellow horns like those of Diesel locomotives, which not only are quite as effective for attracting attention, but also make it easier to tell the direction of the coming train

Drawings by
B. G. SEIELSTAD

Continued use of rattling, screeching trolley cars is inexcusable today, except where war shortages have made it impossible to replace them with recently developed noiseless types

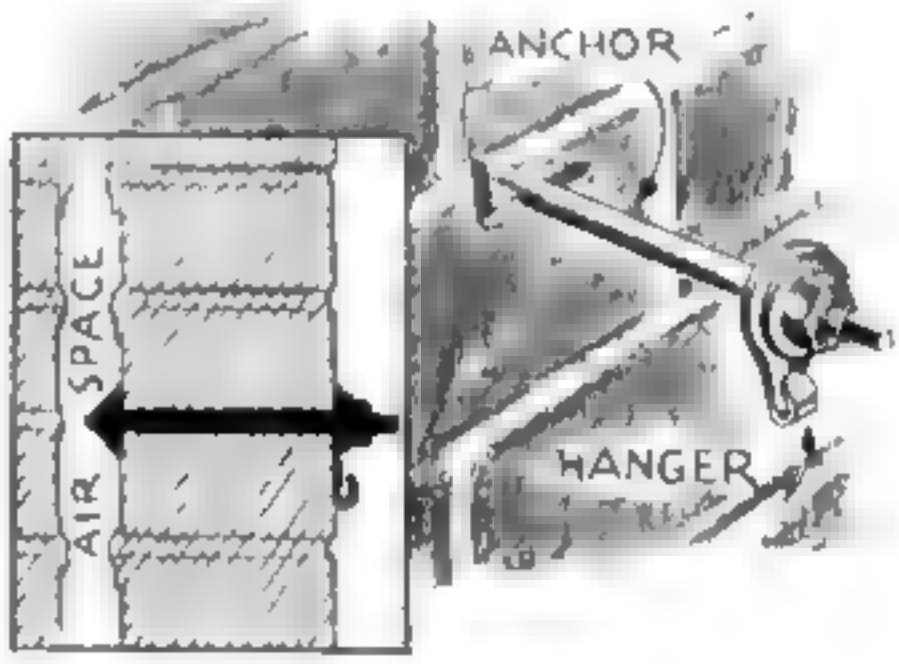
Substitution of welding for riveting in construction, shipbuilding, and manufacture will remove one of the worst noisemakers—the riveting gun whose staccato rattle frays the nerves of workers and everybody else near by

new ideas from the inventors



MECHANICAL THANK-YOU-MA'AM will provide irrigation water at low cost, according to Lee A. Barnett, Los Angeles inventor of a device that utilizes power of passing automobiles at negligible expense. The weight of cars crossing a bridge is converted into energy by a simple application of mechanical principles. As the car is driven onto the bridge, a section slightly elevated by a counterweight is depressed. The downward motion is transferred to two crossed levers that cause a push on a lazy-tongs contrivance, whose thrust is communicated to a ratchet gear connected by a belt with a pump that carries water to a reservoir above.

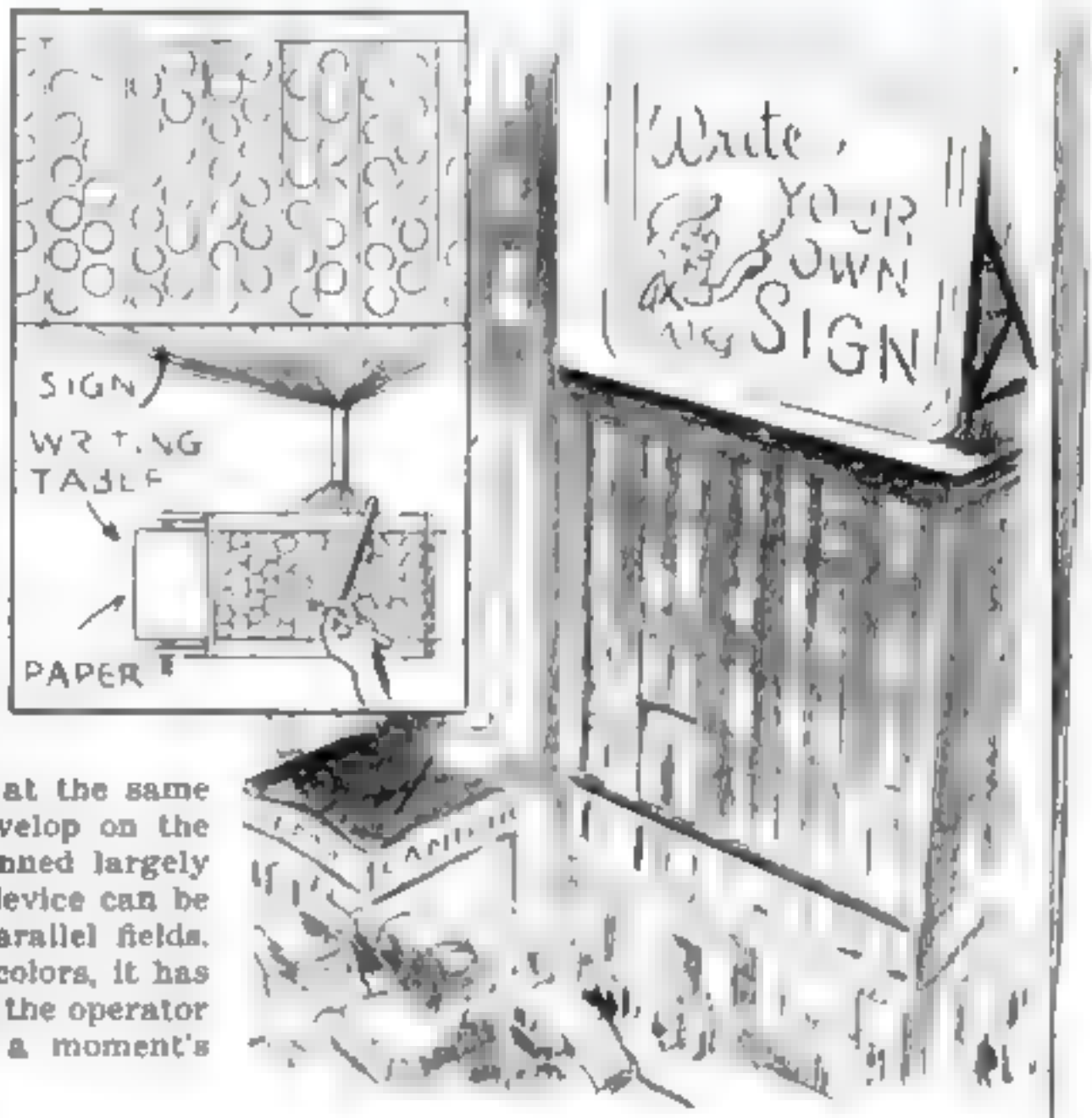
SHRINKING bottle sealers have been patented for use on beverage containers by Raymond E. T. Haff, Greenville, Del., and John Conlyn Creadick and Thomas F. Banigan, Kenmore, N. Y. The covers are made of a cellulose material. They are applied while wet, and dry on tight.



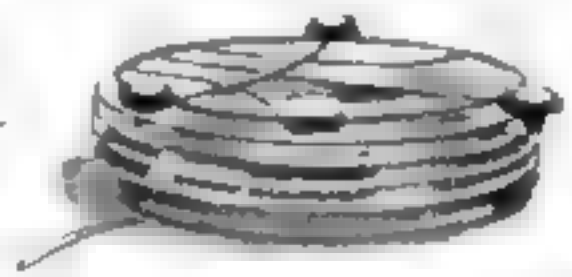
MORE EFFICIENT ANCHORING for hangers in brick or other masonry walls is provided by the spearhead bolt invented by Arthur E. Mullen, St. Louis, Mo. Unlike the common expansion bolt, the new device takes clever advantage of the "air lock," which is a necessary damp-resisting feature of masonry buildings, for it is here that the anchor is securely hooked.

FOOLING FOWL with a new collapsible decoy is the purpose of an invention of Morgan R. Day, North Scituate, Mass. The decoy, which closely resembles the wild water bird, is made of flexible rubber or similar material, and can be readily inflated by the breath of the user. It is easily packed when deflated.

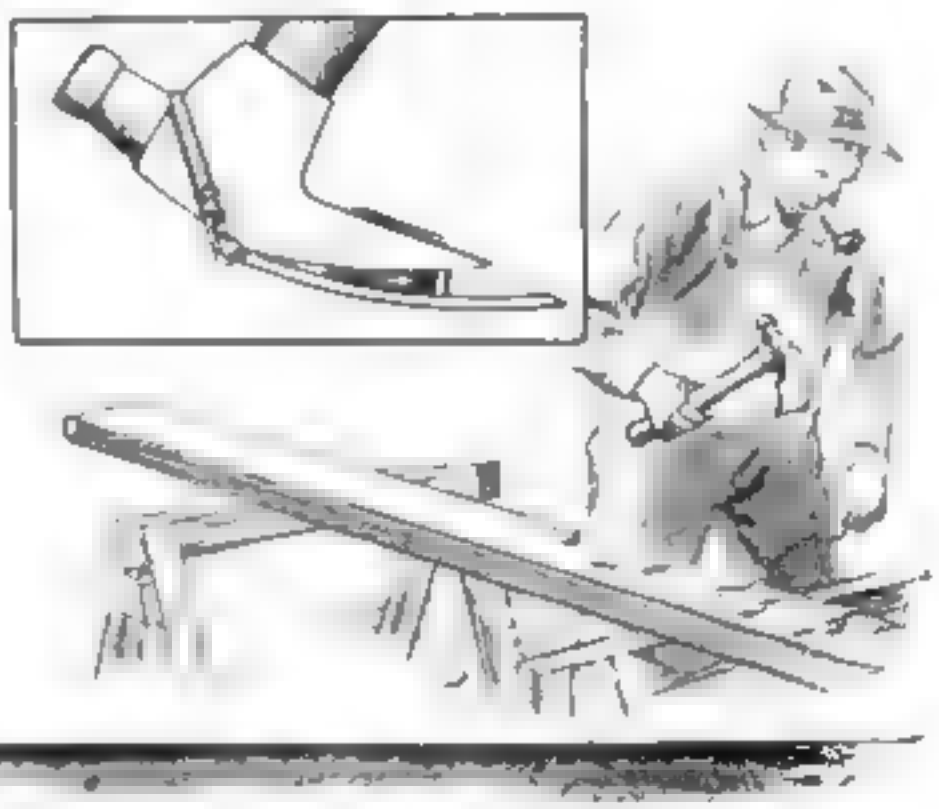
BULLETINS or signs in colored electric lights may be flashed by remote control to outdoor display boards through an invention of Leonard L. and Leonard G. Pruyn, West Los Angeles, Calif. The operator uses a pencil to write his message or ad. The motions and pressure of the pencil are communicated by a movable arm to stationary contacts under the paper, thus closing circuits that control individual lights on the display board. With this Write-Yourself Multicolor Electric Sign, it is claimed that an artist can produce a picture in colored lights, at the same time watching his work develop on the paper in front of him. Planned largely for use in advertising, the device can be diverted to other uses in parallel fields. Besides its adaptability for colors, it has the advantage of permitting the operator to change his message at a moment's notice.



ABOUT THE SIZE OF A TAMBOURINE, but much more useful, is this portable electric fan that can be placed in almost any position while giving a stimulating breeze. Edward A. Ebert, Buffalo, N. Y., is the designer of this handy little cooler for hot summer days.



HAMMER INTO ADZ is the change that can be effected by a blade attachment devised by Leland M. Van Slyke, North Hollywood, Calif. The steel cutting plate is put on over the hammer's claw and is held in place by a wedge lug which fits between the prongs of the claw, and a strap passing under the peen of the original tool. Construction precludes lodgment of shavings between blade and claw. When not in use, the adz attachment may be quickly removed.



VEST TYPE EMERGENCY KIT

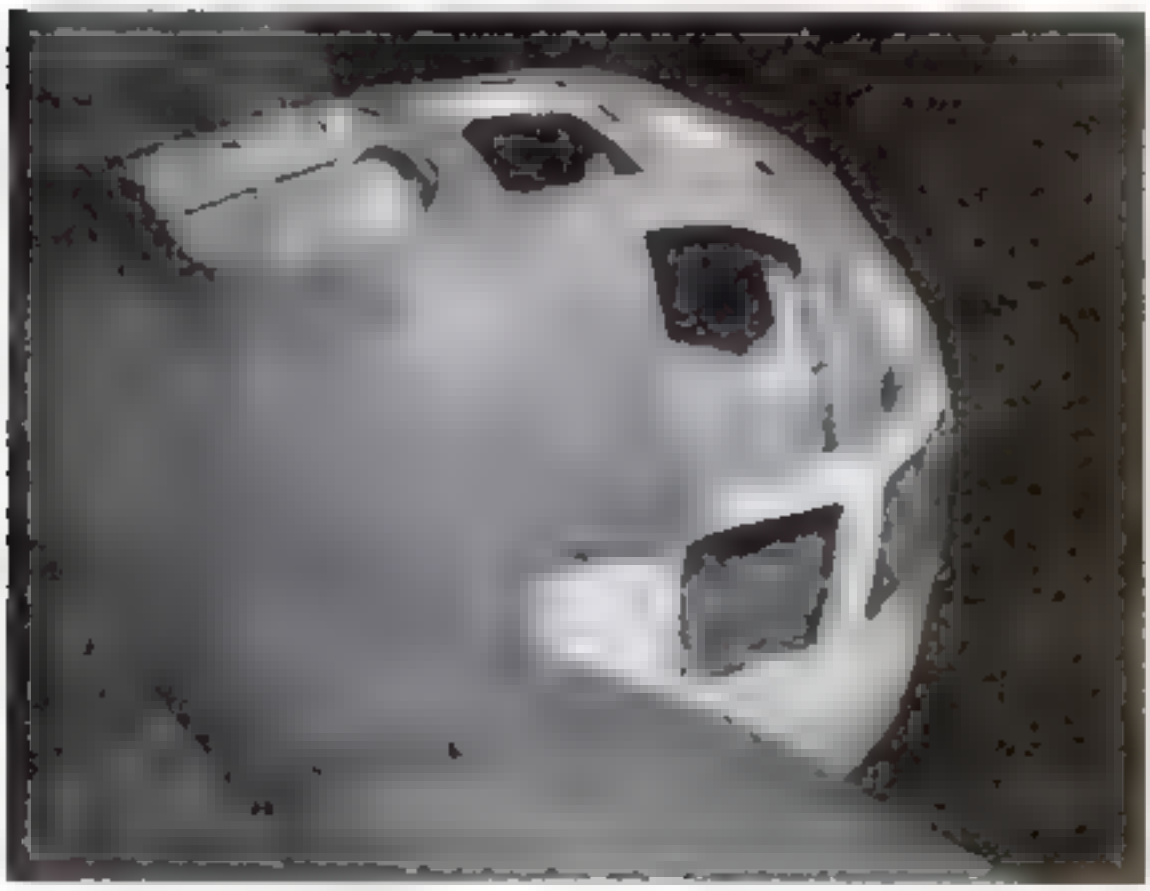
EMERGENCY VESTS containing almost enough equipment to set up light housekeeping have been developed by the AAF Matériel Command at Wright Field, Ohio, for flyers who may find themselves forced down in a jungle, desert, or ocean. In the pockets of the vest (shown at far left) are such items as food, fishing tackle, knives, a revolver with waterproof cover, first-aid equipment, a metal folding pail, and a copy of the famous booklet "Survival," which contains advice on how to get along anywhere.

GLASS AND PLASTIC in laminated sheets are now challenging metals as aircraft materials that are both strong and light. Developed by the AAF, and produced by Owens-Corning Fiberglas Corp. and several plastics companies under the direction of Col. Paul H. Kemmer of the Wright Field aircraft laboratory, the new material proved to be 50 percent stronger than aluminum and 80 percent stronger than wood in strength-weight tests. With the exception of its wings and tail surfaces, the Vultee Valiant basic trainer shown below, for instance, is entirely covered with the new material. One of its highly desirable features is that it can be formed into large intricate shapes without the need of great pressure or expensive molds.

RESCUE BOATS that resemble Navy's powerful PT's are being used by the AAF in areas where flyers may crash at sea. Each boat has a range of 2,500 miles, a top speed of over 40 m.p.h., and carries full first-aid equipment. Armament consists of a 20-mm. cannon and four .50-calibers.

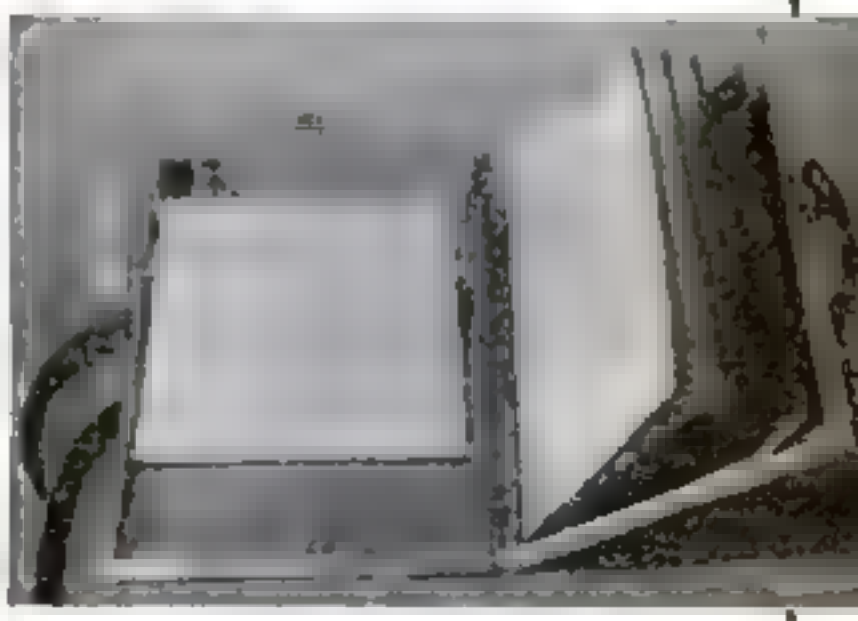
POPULAR SCIENCE

THE MILES 35, a warplane intended for carrier use and so radical in design that in action it has the appearance of a ship that is flying backwards, has now been produced in Britain. As shown in this conception by staff artist Rouse, the ship has a pair of tail-mounted props that revolve on coaxial shafts in opposite directions so as to eliminate torque. Just back of the cockpit is a small, high wing, while at the rear is a low wing of about the size that is usual for such a plane, with stabilizers and rudders at the ends. Developed by George Miles, chief designer of Miles Aircraft, Ltd., the ship is given better stability on the ground by the addition of a rear wheel to the tricycle gear.



SHOOTING THE SUN instead of an enemy plane will be done from this tail enclosure which, as a navigator's station, is replacing the tail turret on the old Martin PBM-3 Mariner patrol bombers that the Navy is converting into cargo transports for use in the Pacific. Designed by the Advanced Bases Aviation Training Unit at Norfolk, Va., the enclosure can be entered either through a top hatch or from the hull. On account of its location, the navigator's sensitive instruments will be comparatively unaffected by the vibration of the plane's engines.

SECRETARY ON HIS LAP. Designed by United Aircraft pilots for use during tests flights, this writing-pad assembly, which a pilot can carry strapped to his thigh where it will be right at hand, includes note paper that moves on rollers, a clip to hold the pilot's pencil, a stop watch, a chronograph, and a compartment at the back of the pad where data sheets and check lists can be kept for easy reference. Pad is shown opened at right.



AUGUST, 1944

A Typhoon set for a sweep over enemy country in the van of the Allied armies. Note the four 20-mm. cannon, long-range wing tanks, air scoop under prop. The cutaway at right, redrawn from "Flight," shows characteristic design features

Engine with Wings

The British Typhoon fighter-bomber, driven by its phenomenal 2,200 horsepower, 24-cylinder power plant, shares honors with the American Mustang in blazing the trail for the Allied invasion.

By HICKMAN POWELL

Photos by HAROLD W. KULICK

THE RAF lads who go rhubarbing in Typhoons say that no form of flying is more exhilarating.

Indeed, speeding over the continent of Europe at 350 miles an hour, maintaining usually an altitude of less than 50 feet, zooming only to miss high-tension lines and rows of poplar trees, banking around houses and windmills, shooting up enemy installations and locomotives on a basis of hair-splitting navigation and split-second timing—all this is hardly to be considered a form of relaxation.

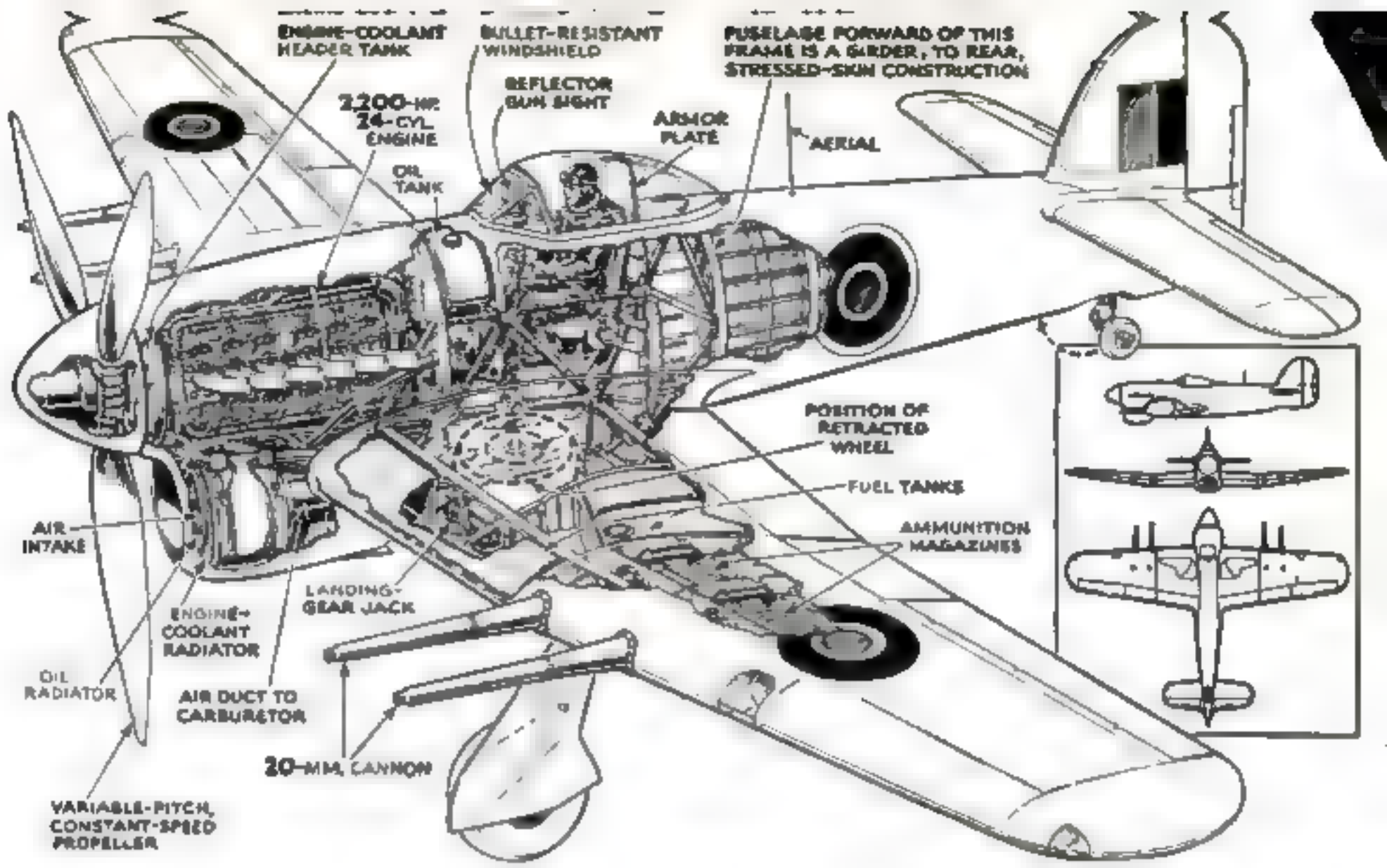
The Typhoon is a bigger and younger sister of the Hurricane, another brain child of Sydney Camm and the development staff at Hawker's. It was first publicly acknowledged after doing a brilliant job on the Dieppe raid, in co-operation with ground troops, in August 1942; but a non-committal atmosphere has continued to surround it, largely because of the absolute secrecy which until recently veiled the new 24-cylinder Napier Sabre engine around which the plane was designed.

This engine, with four banks of six cylinders set in the form of a horizontal H, is of such compact form that, despite its 2,200 rated horsepower, the Typhoon can maintain the slim nose that is characteristic of the Hurricane. Almost doubling the power available to the Hurricane in the Merlin XX, the Sabre drives the Typhoon at well over 400 miles per hour.

Design of the Typhoon was begun in 1937, when the Sabre had been in development for scarcely more than a year. The prototype was flown early in 1940, but the fall of France delayed production. So great was the demand for Hurricanes that summer that planes finished on Saturday were in action by the following Thursday, and there was no time to change over to production of a new type.

The Typhoon is used both as a fighter and as a fighter-bomber, with two 500-pound bombs slung under the wings. Though its 41 feet 7 inches of wing span are only 19 inches more than the Hurricane, and its 32-foot length is only a bit more, its loaded weight of 11,300 pounds compares with only 7,290 pounds in a Hurricane of similar armament. Despite the weight, it is highly maneuverable and is said to turn inside an FW-190.

When hit-and-run German bombers be-



came a nuisance in English coastal towns last year, it was the Typhoons that got rid of them. Skimming the Channel in pairs, they lay in wait. And when the German fighter-bombers struck, the Typhoons, directed by radio, would roar in and hit them before they could get back to the coast of France. It became too costly for the Nazis.

Hunting in bigger packs, the Typhoons have been a scourge to enemy shipping along the North Sea coast. Stringing in one after the other, pouring their shells into a vital spot on a ship, they can sink even big ones.

For a long time, locomotives were a special quarry for lone Typhoons rhubarbing over the Continent. Scouting along a rail line until it spots a train, a Typhoon will

Secret of the plane's remarkable performance is the 24-cylinder, 2,200-hp. Napier Sabre engine, bared for servicing at the right. Below, the rhubarb raider stands beside a flak tower from which a Bofors antiaircraft gun guards the fighter base

This take-off spells trouble for Nazi installations and for overworked German locomotives trying desperately to move men and supplies to counter the Anglo-American thrust. Some Typhoons are armed with 12 Browning .303 caliber machine guns in the wings instead of the four .20-millimeter cannon seen here

Shells for the Hispano 20's are loaded in the wing. A sequence pattern of armor-piercing explosive, semi-armor-piercing explosive, and incendiary shells is used

orbit and come in to catch the engine at 90 degrees. That's the best angle, for while a few shots through the boiler will disable a locomotive, if you hit the boiler right close to the firebox you may get a real explosion.

In earlier days the Typhoons tried dropping bombs from low altitude, but it didn't work. The bombs had delayed action to keep from blasting the planes; and, when dropped at six miles a minute, they bounded across the landscape like golf balls. Sometimes a bomb would bounce for a mile before it went off, which was hardly pin-point bombing.

So one of the early Typhoon squadrons developed a dive-bombing technique, originated by 23-year-old Squadron Leader Dennis Crowley-Milling, who had made an intensive study of German dive bombing against coastwise convoys. Escorted by fighters, the fighter-bombers launch their attack from over 10,000 feet, plunging almost vertically at terrific speed to release their bombs within a few hundred feet of the ground.

The development of the Sabre engine was an audacious venture, late in 1935, when Napier's decided to attempt an aero engine with 2,000 brake horsepower. The largest airplane engine available at the time was of only 1,200 b. hp.; and to try designing such an unusually large power plant in the new twin-crankshaft, H type was to court difficulties.

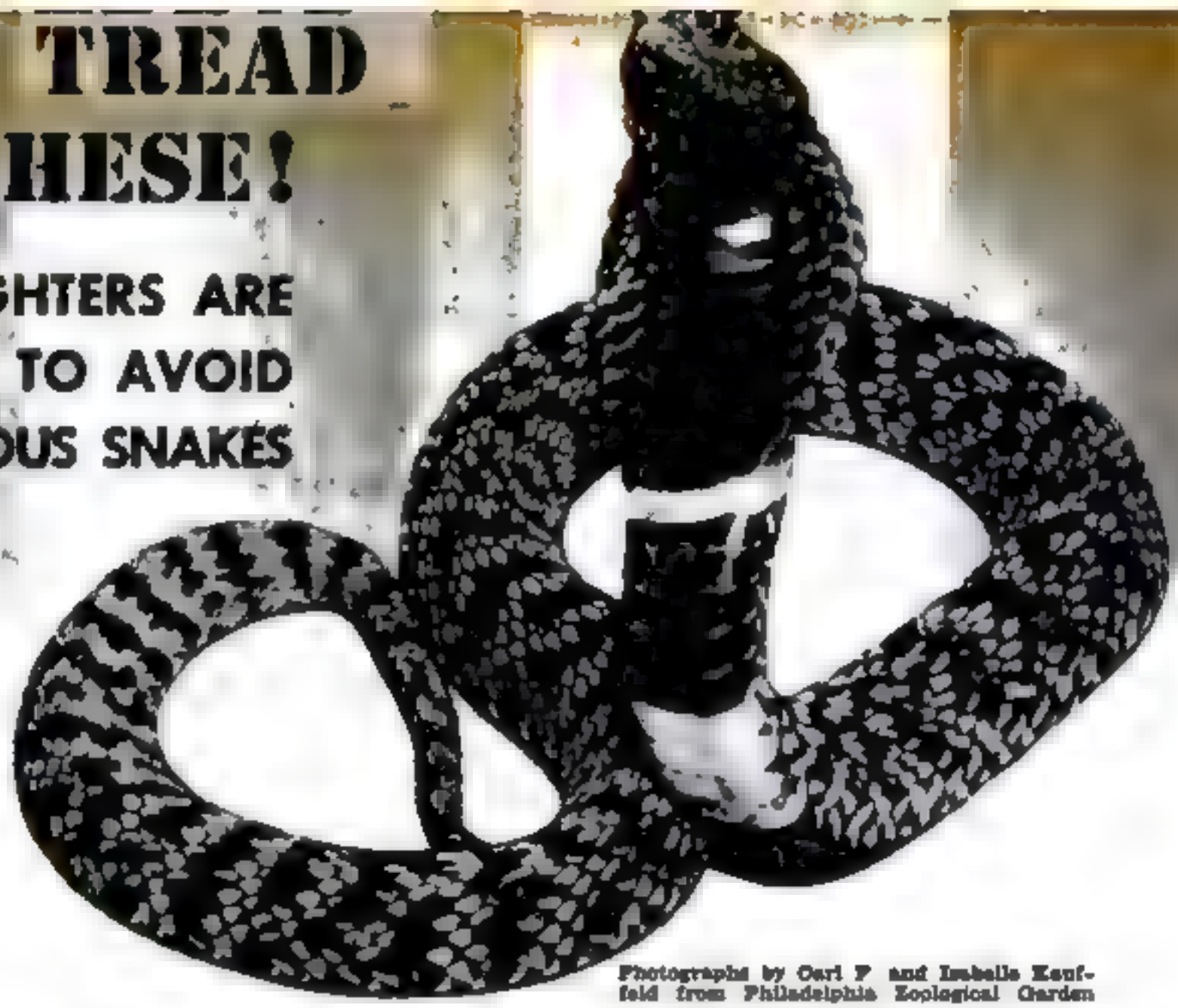
But by June 1940, the engine had passed the official Air Ministry 100-hour test with a maximum power output of 2,200 b. hp. At the engine's dry weight of 2,360 pounds, this figured to a specific weight of 1.07 pounds per horsepower, considered very creditable for a liquid-cooled engine at that time.

THE HAWKER TYPHOON

Jo Katula brings you another Allied fighting plane in colorful action—this time the hell-raising Hawker Typhoon of the RAF. Here's the dope on it: Wing span, 41 feet 7 inches; length, 32 feet; loaded weight, 11,300 pounds; power plant, Napier Sabre 24-cylinder, 2,200-hp. liquid cooled; favorite operating level, treetop or lower. Carries four 20-mm. Hispano cannon or 12 Browning .303's; it also takes two 500-pound bombs

DON'T TREAD ON THESE!

OUR FIGHTERS ARE TAUGHT TO AVOID POISONOUS SNAKES



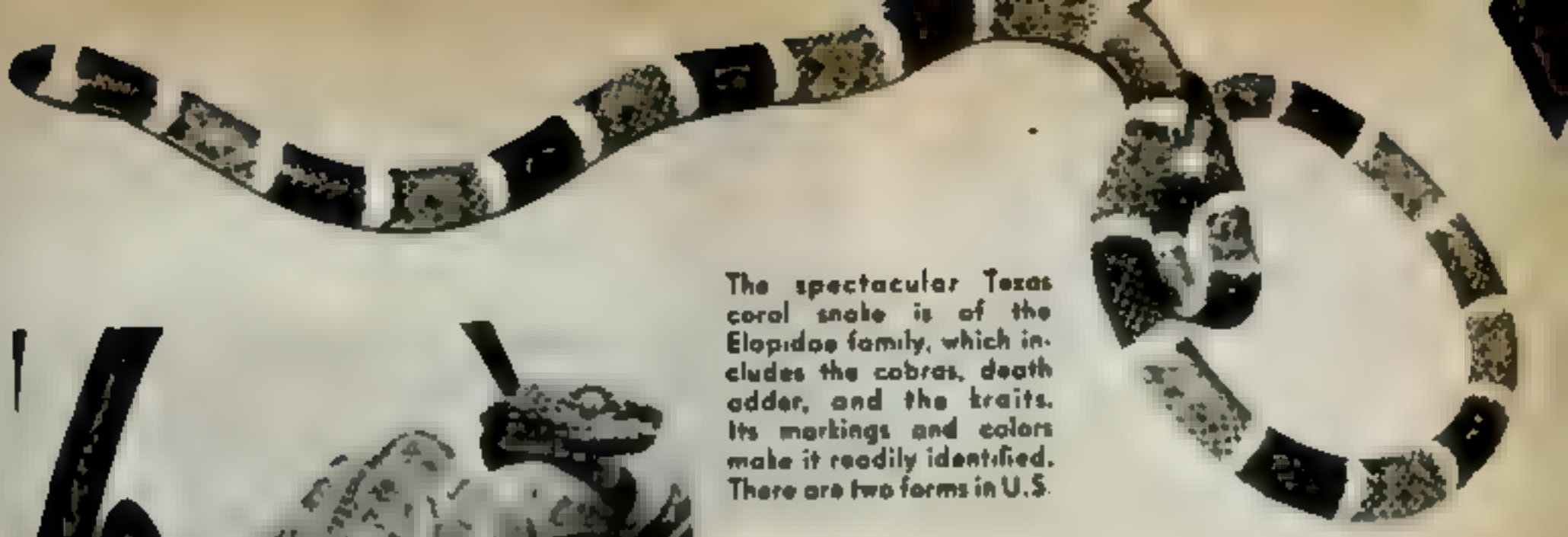
Photographs by Carl F and Isabelle Kauffeld from Philadelphia Zoological Garden

MEN and women of the armed forces, either here or abroad, are in no great danger from poisonous snakes, says Doris M. Cochran, Associate Curator of the Division of Reptiles and Batrachians, U. S. National Museum. The chances of being bitten, she continues, are exceedingly small, but she is positive in her statement that vigilance should be observed while traveling through snake country.

There are only four important families of poisonous snakes in the world. These are Elapidae, which numbers among it one of the few attacking varieties, the king cobra; Hydrophiidae, venomous water snakes of the South Pacific and Indian oceans; Viperidae, with a most efficient poison apparatus that includes retractable fangs; and Crotalidae, of which the main forms are the rattlers, bushmaster, copperhead, and water moccasin. There are but two species of lizards that are known to be poisonous, the Gila monster and the beaded lizard, and they are found only in the United States and Mexico.

Through the co-operation of herpetologists, our men have been taught how to defend themselves against these foes incidental to global warfare. They are warned to wear protective boots or leggings wherever there is danger of encountering snakes, to be on guard while clearing land, never to assume that a snake is nonpoisonous, and never to handle any reptiles. They have had impressed on them the necessity of prompt aid in case of snake bite, and the method of giving it. They know how to apply a tourniquet, slash the wound, and remove the poison by suction. Army snakebite kits contain necessary equipment.

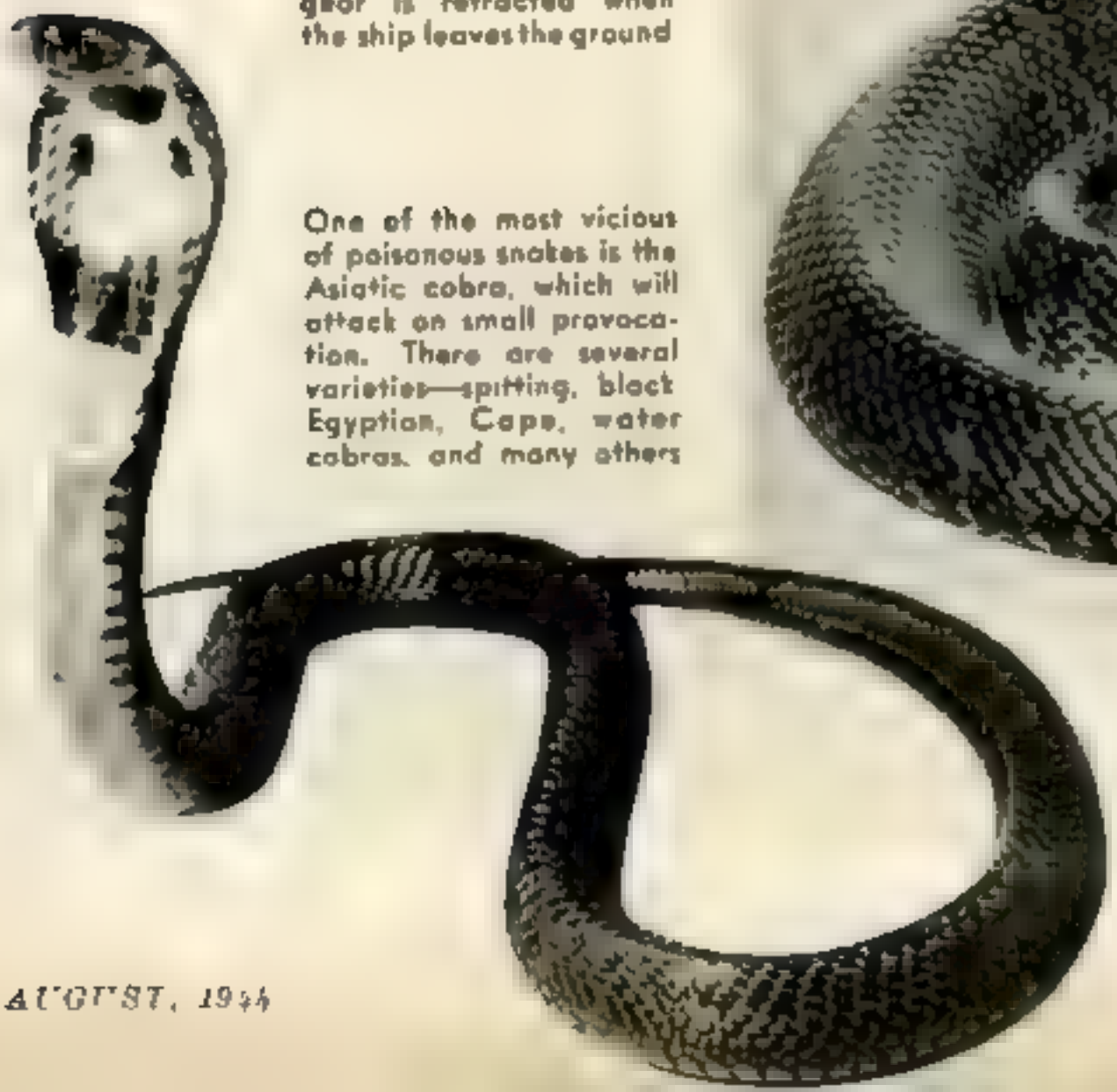
With retractable fangs that can be folded up against the roof of its mouth, the African puff adder is one of the Viperidae that have developed the most efficient poison apparatus of any reptiles. Vipers develop best in Africa



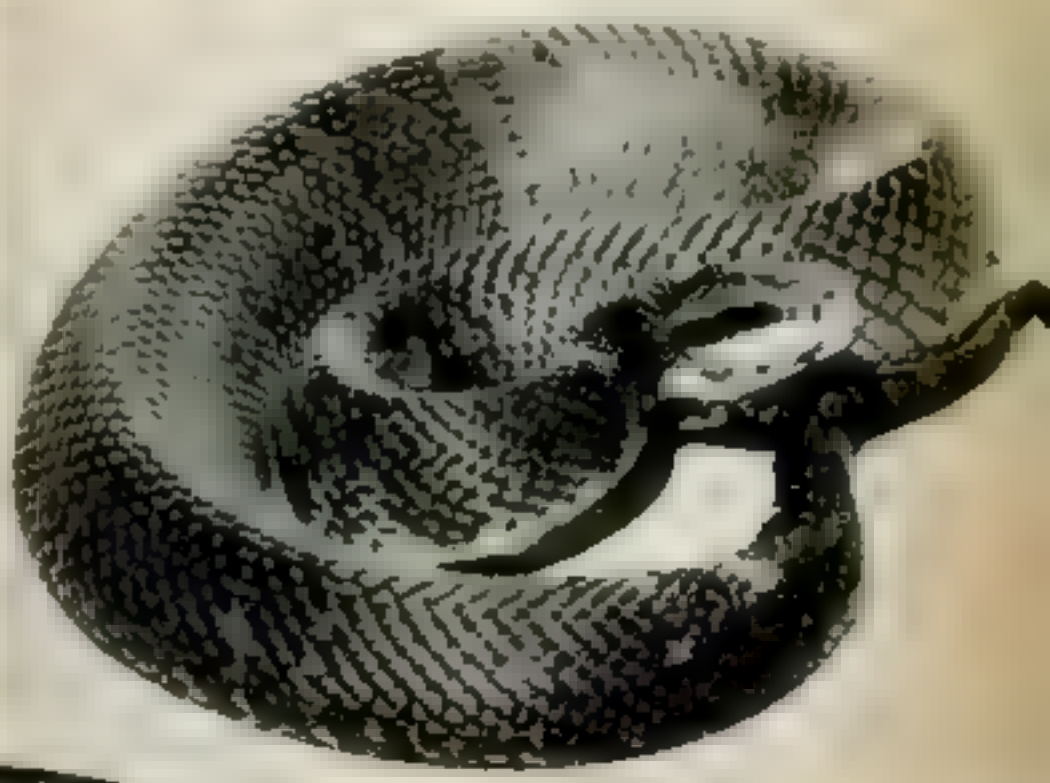
The spectacular Texas coral snake is of the Elapidae family, which includes the cobras, death adder, and the kraits. Its markings and color make it readily identified. There are two forms in U.S.

Schlegel's viper, found in Latin-American countries, is one of the Viperidae, with mobile fangs that can be folded against the roof of the mouth, much as airplane landing gear is retracted when the ship leaves the ground

A called northern copperhead ready to cope with anything-- It has a naturally mean disposition, loathes interference



One of the most vicious of poisonous snakes is the Asiatic cobra, which will attack on small provocation. There are several varieties—spitting, black Egyptian, Cape, water cobras, and many others



The cottonmouth, or water moccasin, shown here is one of the Crotalidae, which makes it a cousin to the rattlesnake, copperhead, bushmaster, and fer-de-lance—all bad actors

FIGHTER GROUP seizes air mastery, thus preparing way for bombing of enemy objectives and subsequent action by ground forces. Shown here is one of this group, the P-47 Thunderbolt, a powerful high-altitude fighter armed with eight .50 caliber guns. It is used for escort and protection of the bombers

New Air Tactics for Invasion

How Planes Smash Battle Bottlenecks

In close teamwork with the men on the ground, tactical air forces clear the way for the big drive. . . . That's "combined operations."

By HAL BORLAND

Photos by HANS GROENHOFF

WE USED to talk about "air support" when our flying forces teamed up with those on the ground to win battles. Today the term is "combined operations." The change is more than a mere matter of terminology; it indicates a fundamental revision of tactics and strategy that has been going on for some months in all theaters. It also indicates that the Air Force is now officially on a basis of equality with the other major forces.

The change can be summed up in one sentence: Air power and ground power now are coequal and interdependent forces; neither is an auxiliary of the other.

It all boils down to fundamental tactics and strategy. In the field we have a tactical air force, consisting of reconnaissance aviation, light and medium bombardment units, fighter aviation, and an aircraft warning service. This air force does not serve the ground forces alone; it serves the whole theater of operations. It is now recognized that if any units of this force are parceled out, the advantage of massed air action will be lost and flexibility will be sacrificed.

So the tactical air force is concentrated under its own command or the command of a theater or task-force commander. In any case, concentration is maintained and independence of action is assured, with the reservation that all action must contribute to the theater's success. Basic tactics call for three phases of action, sometimes called three fundamental missions. These are undertaken in sequence.

The first phase calls for achievement of air superiority. This will be accomplished by attacks against enemy aircraft in the air and on the ground and against all enemy installations that are necessary for maintenance of his air power. Both bombardment and fighter forces are called upon to take part in this preliminary action. It may be noted that this, too, is an essential prelude to any ground action, since successful ground action has been proved dependent on air mastery.

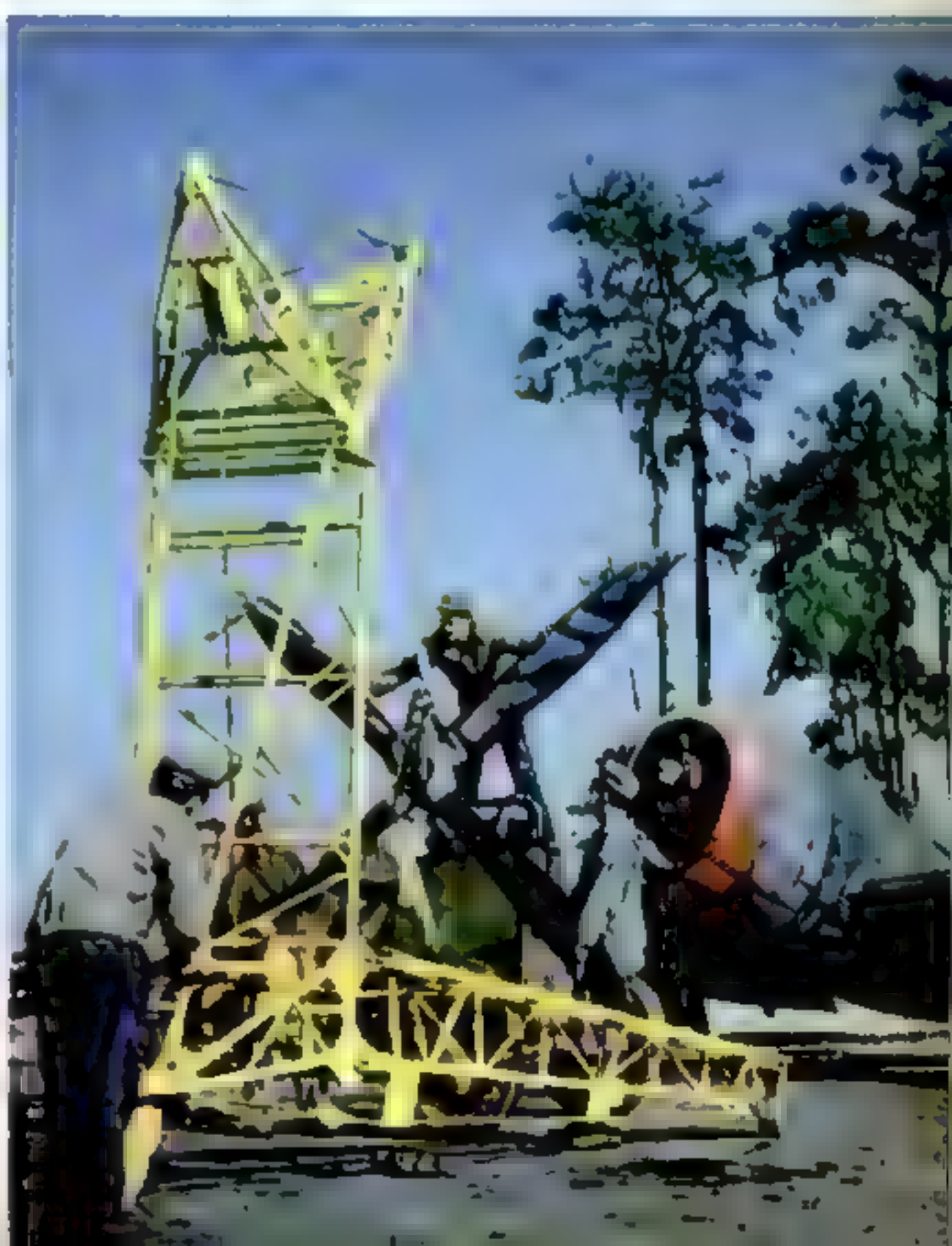
Once air superiority has been achieved, the second phase is begun. This is essentially the isolation of the area under attack.

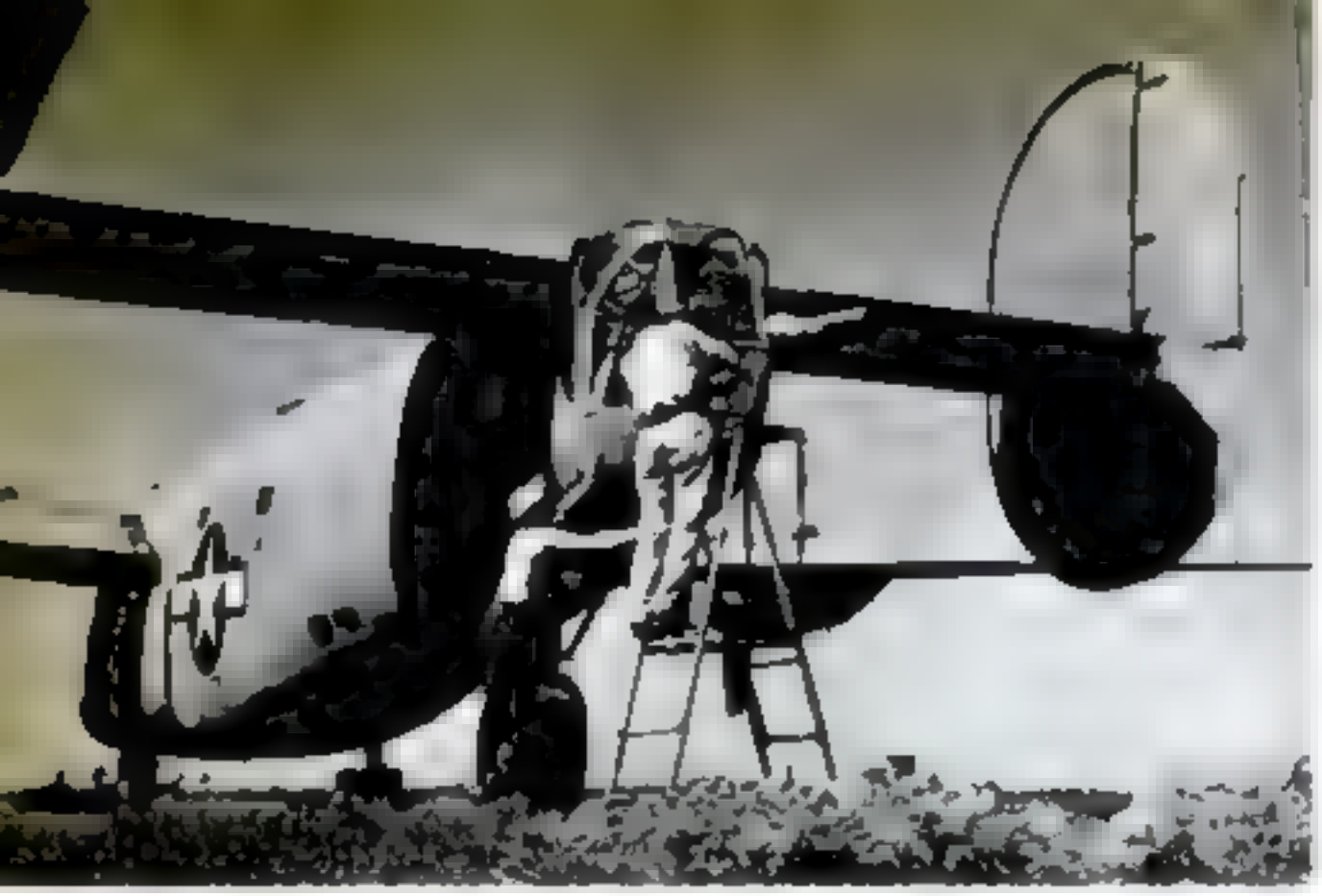
BOMBER GROUP follows the fighter planes, isolates areas under attack by cutting supply lines, disrupting communications, blowing up rail lines, ammunition dumps, and other strateg'c equipment Here is a B-17 Flying Fortress in mixed formation with other bombers behind the wing of a Liberator

It means cutting of supply lines, disruption of communications. Here again both bomber and fighter forces are necessarily in action, though the targets now are rail lines, highways, food and ammunition dumps, radio stations, ports and harbors, airfields. Here again we have the preparatory phase, though now considerably advanced. When it is completed, we are ready for vigorous ground action. During this second phase, of course, there has been considerable ground activity, particularly in artillery bombardment and in commando or ranger-type infiltration and destruction of installations

The third phase corresponds roughly to what we used to call "air support." It is direct attack by co-ordinated air and ground forces—the assault, capture, and occupation of the enemy area. The closest kind of teamwork is necessary Air cover prevents or minimizes enemy air action against the ground forces. As new airfields are occupied by our

AIR SERVICE FORCES perform a necessary function among the many involved in combined operations. Here a ground crew is shown lowering a P-47 Thunderbolt propeller onto a "prop dolly" in preparation for servicing or making repairs. Details of the new tactics were born under fire and tested under the most difficult conditions that could be simulated here at home





VALETING GUNS in the tail of a B-24 Liberator—one of the many services that are constantly required of maintenance crews in combined operations. The big idea is not only to keep 'em flying, but to keep 'em shooting as well. (No complaints so far)

ground forces, our engineers put them into shape for use by our air forces. Massed air action in any particular area paves the way for ground advances. Air force acts as long-range artillery to silence enemy activities. It blasts tank concentrations. It strafes hostile installations and discourages concentrated enemy resistance. Again, all types of air units are in action, concentrated at times for a particular purpose and overlapping in function. It is air support in the true sense; but even while it is going on, there is the co-ordinate of ground support for the air force. If all three phases have been carried out according to schedule and plan, the third phase ends in victory for the combined operation.

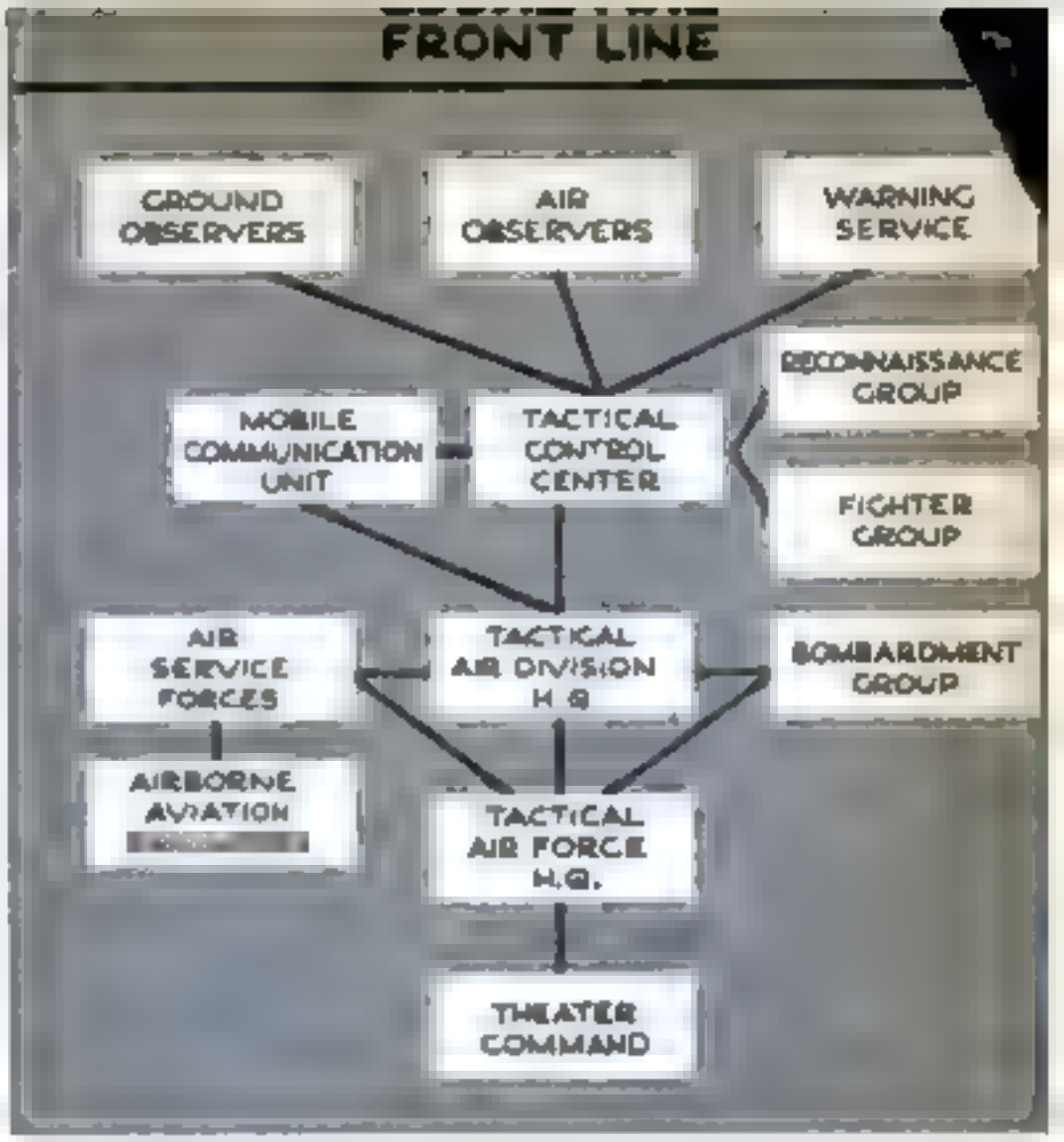
That is the over-all plan; these are the basic tactics. They are altered to fit the situation, but, except for particular emphasis on one phase or another, the pattern is followed. It has the advantage of flexibility and massed force that has proved essential to success. With only slight alterations, it works in the broad stretches of the Pacific as well as in the relatively narrow land corridors of Europe. In the Pacific, of course, sea forces are brought into the picture, supplementing both air and land forces; but the basic pattern holds true even there.

Take a typical land operation and follow it through:

We have a combat theater where our forces face strong enemy forces and installations. In our air arm we have the usual units—reconnaissance aviation, both visual and photographic; light, medium, and heavy bombardment; adequate fighter force and maintenance units, and a complete aircraft warning service and defense setup. Reconnaissance has already given us the general outlines and considerable detail of the enemy's strength. Now our reconnaissance fills in the gaps in the picture, with flights at all altitudes and the wealth of photographic material resulting from such work. From the photographs, charts are made, bombardment groups are briefed, and fighter groups informed of particularly hot spots.

Bombers and fighters go to work on airfields, not only in the theater but well beyond, wherever it is logical that the enemy will be concentrating air support or air attack for this particular area. A part of the bombardment program is designed to drive the enemy's fighter force into open

FRONT-LINE REPAIRS are made by skilled soldier workmen under fire. This is a primary maintenance truck equipped with the proper tools to handle all but the major mechanical difficulties that are bound to arise when ground and air forces go after the enemy simultaneously



COMMUNICATIONS' PATTERN for an air force serving the whole theater of operations. The commander, working through the tactical air force headquarters, tactical air division headquarters, tactical control center, and the air observers, keeps in close touch with the entire operation both in the air and on the ground. This provides maximum flexibility

combat, for we have the strength to meet and defeat him in the air—we hope. We cripple or destroy his fields, blow up his fuel and ammunition dumps. Our fighters, alone or escorting the bombers, engage the enemy's fighters and eliminate as many of them as possible. Meanwhile, of course, a part of our fighter group is assigned to defense, for the enemy is now probably aware of our plan and is attempting to break up our own concentrations. But the defensive program also has its own secondary purpose of eliminating enemy fighters.

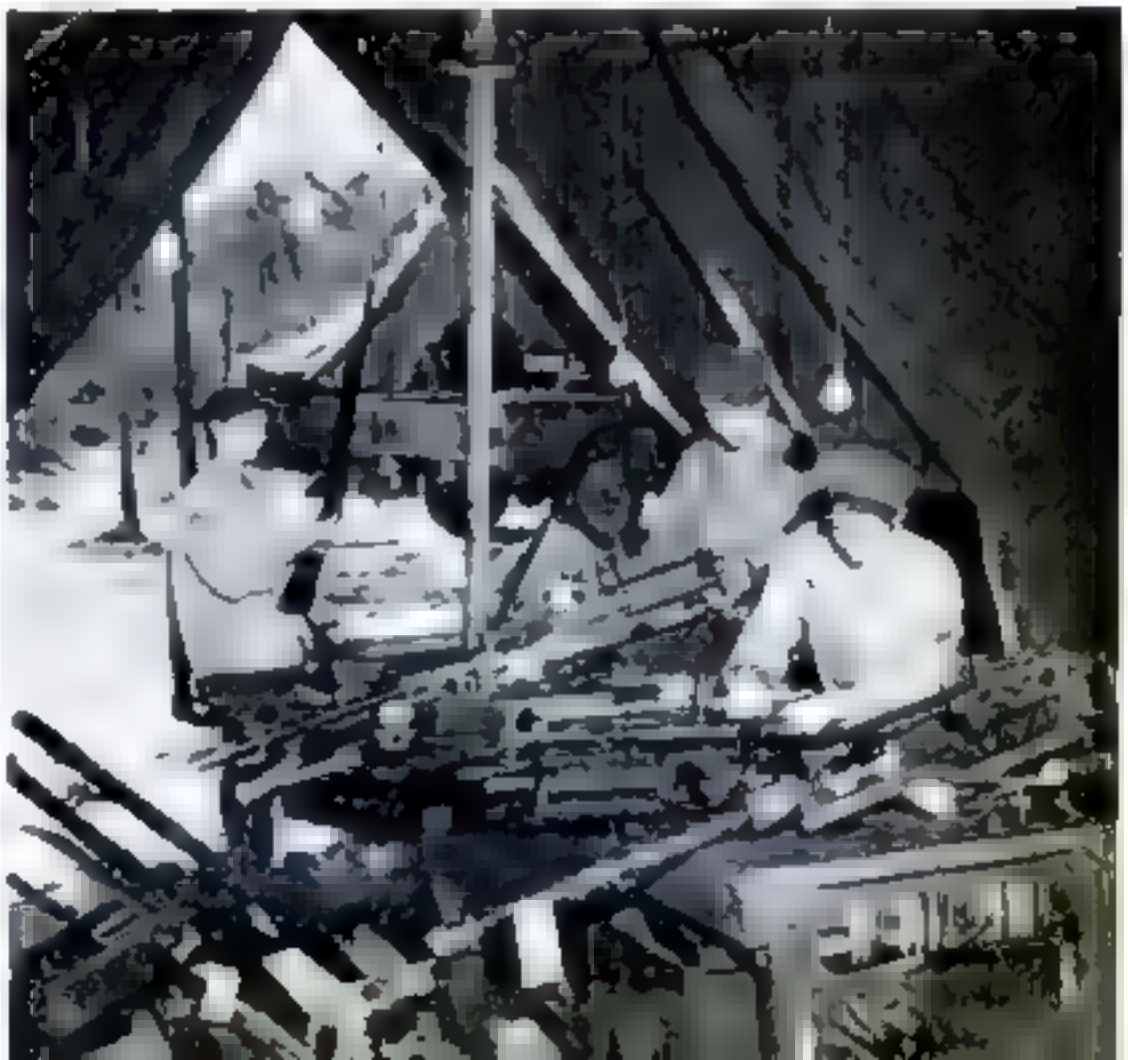
The missions are flown. Enemy airfields are crippled and enemy air strength is reduced to a point where we can send our bombers out to attack secondary-phase objectives—railroad yards, bridges, highway junctions, tank concentrations. We have begun to work on the isolation program, and if the enemy is as bright as we have to expect him to be, he must see that we are systematically plowing a furrow of destruction around this one area. He will begin moving reinforcements into position to ward off the next blow. That in turn will call for bombing well beyond the theater's perimeter. And we will keep up the attack night and day to prevent his getting set for us. He must not have time to repair his roads or rebuild his bridges. The tempo of our attack must increase steadily.

Meanwhile, our reconnaissance will be out every hour of the day, checking on the results of our air attack. Photographs will be compared back at headquarters. Strong points will be analyzed, damage appraised, possibility of repairs weighed; new missions will be set up and run.

By this time our ground force will be moving up. It (*Continued on page 223*)

AIRPLANE PROPS BEING TOTED to a field maintenance tent on special dollies for a checking, while combined operations make it hot for the enemy not for off

GUNSMITHING in the field is another of the myriad items in the ground-and-air-force repertory. The shotgun is emergency equipment for game, and is included for flyers who may be grounded in a remote spot



These glamorous gunstocks were carved and fitted by a New York man in his hobby workshop. The upper example is of golden bird's-eye maple on a 12-gauge L. C. Smith (Specialty Grade) trap gun; while the lower is of Oregon myrtle on a Model 70 Winchester hunting rifle of .30-06 caliber with bolt action. Watchmaker precision must be observed in creating a stock with the perfect alignment necessary to accuracy

Hand-Carved Stocks

Photographs by WILLIAM W. MORRIS

THE wood-carver's craft plus the gunsmith's skill plus an eye for color and design add up to a spectacular result in Al White's hobby of fashioning and fitting gunstocks in his home workshop.

One day while hunting in the Maine woods, this New York advertising artist stumbled over a chunk of bird's-eye maple. He got a thrill similar to that of the discouraged miner who kicked over a stone and found gold underneath. Lugging the wood back to his workshop in Brooklyn, Al White figured that it was the raw material for the finest gunstock of the already fine collection he had carved. He put the wood away to season.

After letting it age until the wavy golden grain showed its eyelike markings, he shaped and carved the butt, comb, pistol grip, and beaver-tail fore end. When he had finished it to his very critical standards, he fitted the stock to his L. C. Smith 12-gauge (Specialty Grade) trap gun, and there was another museum piece.

Wood-carving skill alone does not suffice to achieve the results that Mr. White has

In shaping a gunstock, all measurements must be carefully checked, for unless the user's height, length of neck, and reach of arms are taken into consideration, the gun may tend to shoot high or low. Here the carver is taking an alignment measurement for the drop at the toe (front) and heel (rear) of a new stock. Picture at right shows the fore end of trap gun illustrated at top of page. It is carved in a beaver-tail design with finger grips

Al White knows his guns, lock, stock, and barrel. He is holding the Winchester rifle whose stock he carved from Oregon myrtle (lower of the guns left)

Embellish Costly Guns

shown. One must understand the anatomy and workings of the gun itself, the differences between shotgun and rifle stocks, and the probable user's size, build, and aiming habits. Also, a hobby like Mr. White's can run into money. Reasoning that a gun should be worthy of its stock, the hobbyist recently paid $800 for an original Charles Daly gun breech and barrel, for which he is now carving a dark walnut stock of the Monte Carlo type. This gunstock sculptor is not satisfied with any but the most beautifully grained and colored woods, flawless and thoroughly seasoned; and as for workmanship, there can be no doubt that he is his own severest critic

The carver believes in the Wall Street advice to diversify your stocks. Here are four of his masterpieces showing color range and how the design of the stocks is varied according to the type and balance of the gun. The stocks, in order from top to bottom, are of bird's-eye maple, American crotch walnut inlaid with mother-of-pearl, bird's-eye maple, and Oregon myrtle. All are brought to a high finish before they are ready to be displayed

Weird Dwellers of the Deep

THESE MIDGET MONSTERS ARE DEEP-SEA TROPICAL FISH

A looking-down view of the black-winged flying fish of the Pacific Ocean. This kind really flies, thereby differing from the familiar variety that flaps its tail so hard on the surface of the water that it soars horizontally for some distance

RESEARCH among tropical deep-sea fishes, combined with keen artistic skill, has resulted in a remarkable series of pictures by George Alan Swanson, a New York artist who has worked with Dr

George Alan Swenson, artist-scientist, is painstaking as to detail. Here he examines the teeth of a deep-sea fish that he is about to sketch. His pictures must be right, to the last tooth

These tropical fish are from the west coast of Mexico. Specimens taken from great depths are brought to the surface slowly, thereby allowing time for decompression so that they will not burst

Among some of the coral reefs of the Pacific, the artist discovered a wide variety of specimens that showed astounding diversity as to shape, size, and behavior, and whose colors, while the fish were alive, ranged pretty nearly all over the spectrum

Two drawings of eels from coral reefs in the warm seas of Central America. The larger is a ferocious, savage moray eel, while the smaller picture at the top represents a young eel from coral. Swanson visited them in a diver's helmet to insure accuracy

William Beebe, of the New York Zoological Society, on many of his famous expeditions. The artist has personally investigated the depths of the Atlantic and Pacific oceans, penetrated the jungles of Central and South America, and then returned to record graphically the story of his findings. In making these pictures, Swanson not only has made use of his expert draftsmanship, but has drawn on a thorough scientific knowledge of his subjects, covering their habitat, anatomy, and coloration.

They call it the yellow-tailed surgeon fish because of the sharp, lancelike spines near its tail. Swanson actually counted the spots so that the picture could not be rejected by even the most hypercritical

Fighting at 425 Miles an Hour

IT TAKES A GOOD MAN TO FLY THE NEW P-51, WORLD'S FASTEST, LONGEST-RANGE FIGHTER. MEET THE RIDERS OF THE MUSTANG.

By HICKMAN POWELL

Photos by HAROLD KULICK

FROM A MUSTANG BASE IN ENGLAND

YOU can't say that Howard put the new Mustang on the map, because the P-51 did that for itself, with a big bang, by escorting the daylight Fortress raids deeper and deeper into Germany.

When they had enough Mustangs the bombers raided Berlin, and did it day after day. Probably that simple statement means more than to say it is the fastest airplane in the world.

Or to say that the Mustang is the highest-flying, lowest-flying, longest-range fighter we have among all the superlative aircraft going out to strike the enemy.

Or that it takes a very tough man to keep up with the endurance and dependability of this light, fast-accelerating, maneuverable fighter, with its Packard-built Rolls-Royce Merlin engine. For the Mustang doesn't merely fly 500 miles into Germany, fight over the target for an hour and a half, shooting down four enemies for every loss, and then come home. It does this day after day after day, with hardly a bit of tinkering to be done on the ground.

All these things are true of the Mustang, and outstanding in themselves. But it was Howard's exploit that first really dramatized the arrival of this new fighter in the European Theater. Howard's few seconds of heroism were the bright spot in the black day of January 11, 1944, when 60 Fortresses went down in the raid on Oschersleben. So in telling about this wonder aircraft of 1944, it is natural to start with Howard and the incident which one grateful Fortress man described as "one lone American taking on the entire *Luftwaffe*." Single-handed, he had fought with more than 30 German planes.

After all, if it hadn't been for the qualities of his plane "Ding Hao" (which is Chinese for "O.K."), Howard could never have done it.

II

Col. James H. Howard was a member of the Ninth Air Force fighter group which

New Mustangs are now delivered with their silvery aluminum bodies unpainted. The omission of paint results in a reduction of weight and drag that adds 10 miles per hour to their speed—one of many factors that make them the fastest and longest-range fighters in the world. The speed gain offsets the loss of camouflage

Col. James H. Howard, who "took on the whole Luftwaffe single-handed" in the January 11 raid on Oschersleben, is the only American flyer who rates as an ace against both the Japs and the Germans. His fighter group was the first to be equipped with the improved P-51

was the first outfit to be equipped with the new, improved Mustang. Originally he was a squadron leader. He succeeded to the command of Col. Kenneth Martin, who went down in a head-on collision with an ME-410 during a raid on Frankfurt. Howard is the only American who rates as an ace against both the Japs and the Germans. He is no glamor boy, but a seasoned, professional flyer, 30 years old.

Howard got his flight training as a naval air cadet at Pensacola in 1937, then served on the aircraft carriers *Lexington*, *Wasp*, and *Enterprise*. He wasn't any too satisfied in the Navy, foreseeing himself years later still flying the wing of some young officer from Annapolis. So in 1941 he resigned his commission and joined up with Chennault's Flying Tigers, the American Volunteer Group, to fight in China. Howard was born and brought up in China, son of an American doctor in Peking, but he can't recall that his volunteering had much to do with helping the Chinese. He wanted to get ahead as a fighter pilot. He wanted to participate in the development of new fighter tactics.

He got his chance at the tactics. Around the officers' mess table in Burma he found a lot of young flyers hotly debating various ideas of how to fight in the air. Then

Little friend and big friend: Fighters and bombers seldom meet except in the flak-filled air above enemy territory, since they operate from different bases. Here, however, a P-51 is shown with a Fortress that made an emergency landing at a Mustang base after having been pretty badly shot up with rocket shells

these lads went out against the Japs to try the ideas, most of which turned out to be pretty poor. But out of these experiments over China came the two-by-two tactics used by American fighters today. Howard says the two-by-two idea originally came from the Germans, and its importance can be exaggerated. He says the important thing is to be willing and eager to try out new ideas. With the rest of the AVG, Howard tried out ideas on 56 combat missions. He shot down a half dozen Japs before coming to the ETO.

The opportunity to try new ideas came again to Howard when he was assigned to Mustangs. Up until then, he had flown Navy fighters, P-40's, Lightnings, and P-39's. On December 1, 1943, in England, his group got the first shipment of Mustangs and set out over Europe to find out how good they were. For a month they felt their way. Then in January they started going, not to town, but to one German city after another.

The long range of the Mustang made possible a new development in the technique of escorting heavy bombers. Up to now the bomber formations had proceeded to the target under protection of successive groups of Thunderbolts, each of which flew with the procession for a while (either on penetration or withdrawal) and then retired when its gasoline ran low. Now the Mustangs, because of their long range, took over the sector above the target. Owing to their small numbers at first, the Mustangs would not stay with any one combat wing of bombers; they undertook to give "area support," staying over the target area for as long as an hour and a half, while as many as 10 combat wings of bombers came in, made their runs in the danger zone over the target, and departed

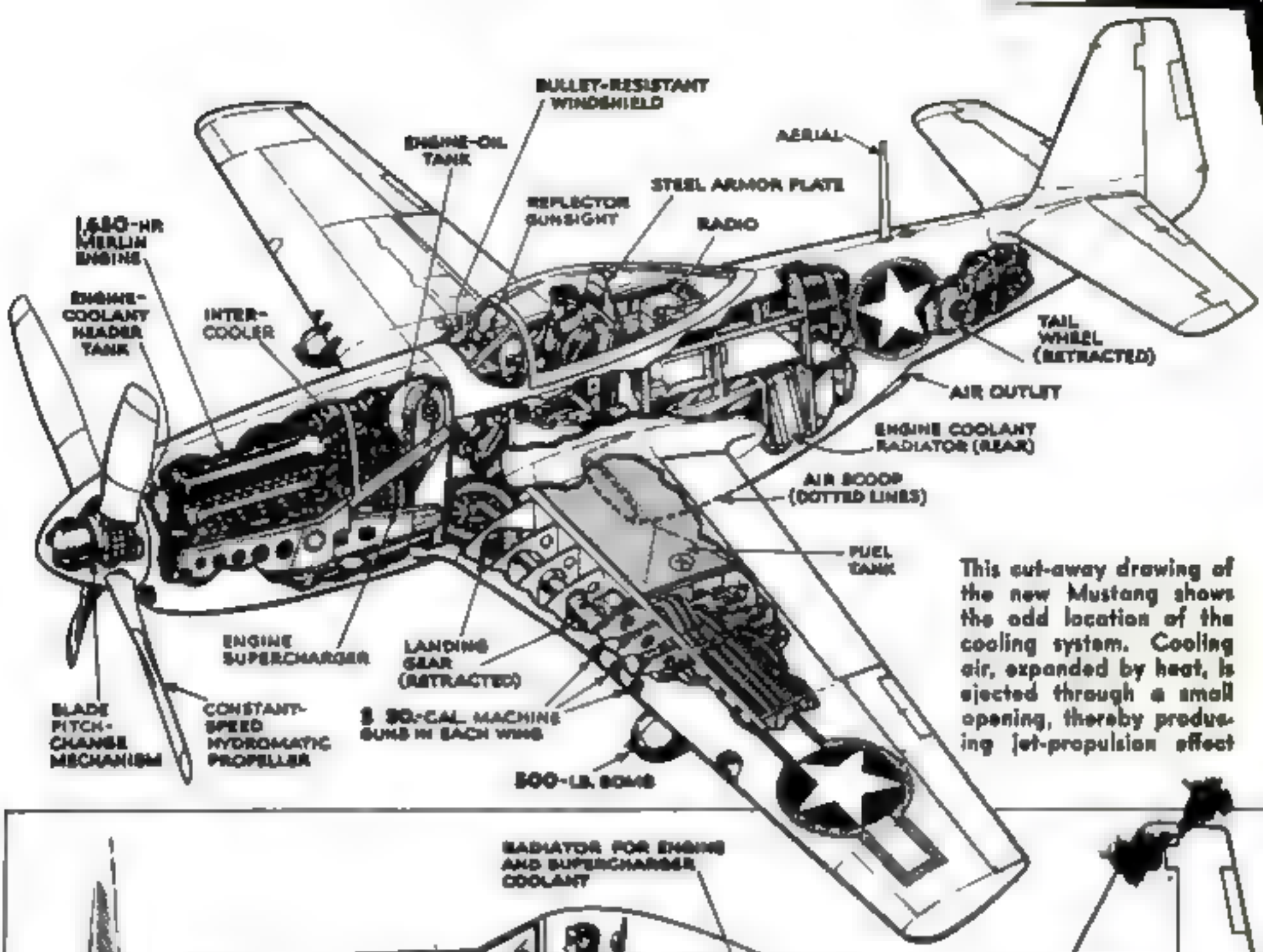
Opening immediately behind the four-bladed prop is the air inlet for the two-stage supercharger which helped to hoist the effective ceiling of the new P-51 three miles above that of earlier models

The raid on Oschersleben on January 11 was one of the deepest yet attempted, and the Mustangs were to give target support beyond range of the Thunderbolts. The Mustang group, flying under Howard's command, made its rendezvous with two boxes (combat wings of 54 each) of bombers right on the dot.

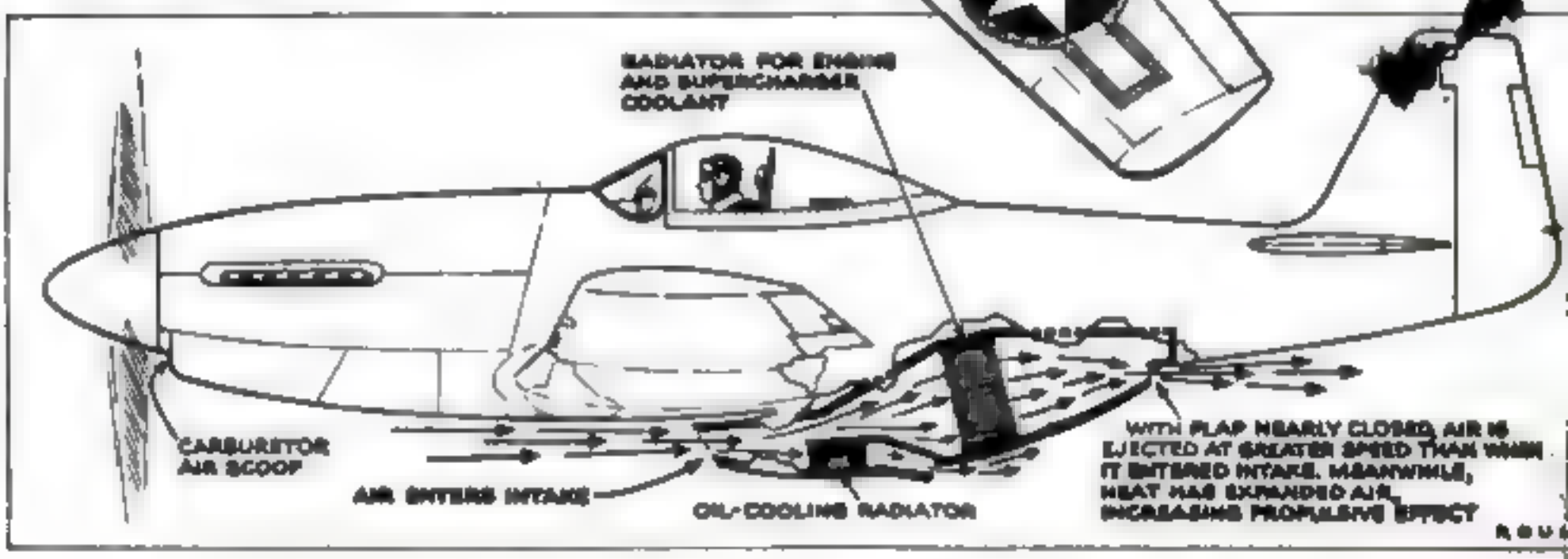
But then, over the RT, came bad, startling news. A third box of bombers had got ahead, out of sight. And right now the Messerschmitts and the FW's were swarming in on it, blasting it unmercifully. Leaving two squadrons to protect the two boxes of bombers (which, as it turned out, were not attacked at all), Howard took his own squadron to the rescue of the third combat

Reduction of drag is furthered by the new bubble canopy, which also gives the pilot better visibility. The only fault the pilots find with the plane is that six hours of flying in this tiny cockpit gives them a pain

Wing tanks are loaded from a small gasoline dolly with a hand pump. These tanks, which can be dropped when empty, help give the Mustang the long range that enables it to protect bombers



This cut-away drawing of the new Mustang shows the odd location of the cooling system. Cooling air, expanded by heat, is ejected through a small opening, thereby producing jet-propulsion effect



The air intake for the cooling system is placed below the wing surface, where it will not catch the disturbed boundary air. Location of the cooling plant far to the rear gives clean lines to the nose and edges of wings

Part of the cooling air is diverted through the small oil-cooling system and passes out through a front flap shown below. The larger, rear flap is closed in flight Most air passes through engine-cooling radiator

...e bombing of Europe reached its climax, the new Mustang was accepted for use as a bomber at low and medium altitudes. Here blue practice bombs are being loaded for dive and skip-bombing rehearsal. The two wing-tank racks will be used as bomb racks, each of them capable of holding one of the 500-pound "duds"

wing, which was unprotected.

The sky was alive with German fighters when they caught up. The Mustangs struck, and in the melee Howard's flight lost him. He had to fight on alone. At least he says he had to, quoting the old Chinese proverb: "He who rides the tiger cannot dismount."

After it was all over, flying back home with the stick in one hand and a pencil in the other, Howard jotted down notes on his knee pad, trying to disentangle the events of the last few minutes, when he had been alone among the German swarm. Here is what he wrote when he got home:

"When I regained bomber altitude, I discovered I was alone and in the vicinity of the forward boxes of bombers. It was here I spent approximately a half hour, chasing and scaring away attacking e/a (enemy aircraft). Each time I would climb back up to bomber level only to find another e/a tooling up for an attack. I was quite busy in a constant merry-go-round of

Another swastika is added to Howard's scalp rack. The six rising (?) suns stand for Nips he brought down while he was with Chennault's Flying Tigers in China. Curiously, the American ace was born in China. His plane's name, "Ding Hao," means "O. K." in Chinese. He has also flown P-38's, 39's, 40's

Heart of the new Mustang is the Rolls-Royce Merlin engine as built in Detroit by the Packard Motor Company. Souped up to a vast increase over the power of the Merlin in the Battle of Britain, it has an announced horsepower of 1,520, and its two-stage supercharger can maintain full power well above 30,000 feet. One P-51 Merlin pulled "emergency" manifold pressure for 40 minutes without harm

climbing and diving on attackers, sometimes not firing my guns but presenting a good enough bluff for them to break off and dive away . . ."

Now the first principle of today's fighter tactics (learned from the Flying Tigers after their experiments in China) is that when a fighter makes a bounce, he wants a wing man to protect him. But Howard was trying something new.

The excitement started when the Fortresses got home, the battered remnants of those which had stood the brunt of the attack. They had not only taken a terrific shellacking; they had had grandstand seats for an amazing one-man flying circus. They insisted on a search of combat reports to find out who this flyer was. Howard's report seemed to fill the bill.

The commander of the battered combat wing wrote Howard the following:

"Your unprecedented action in flying your P-51 alone and unaided into a swarm of German fighter planes, estimated between 30 and 40, in an effort to protect our Fortresses in the target area, is a feat deserving of the highest commendation . . ."

This went on for some hundreds of words. Howard himself put in a matter-of-fact claim of two enemies destroyed, two probables, and one damaged. The combat assessment board, after skeptically reviewing the available facts, couldn't quite swallow that one. They credited him with three outright kills.

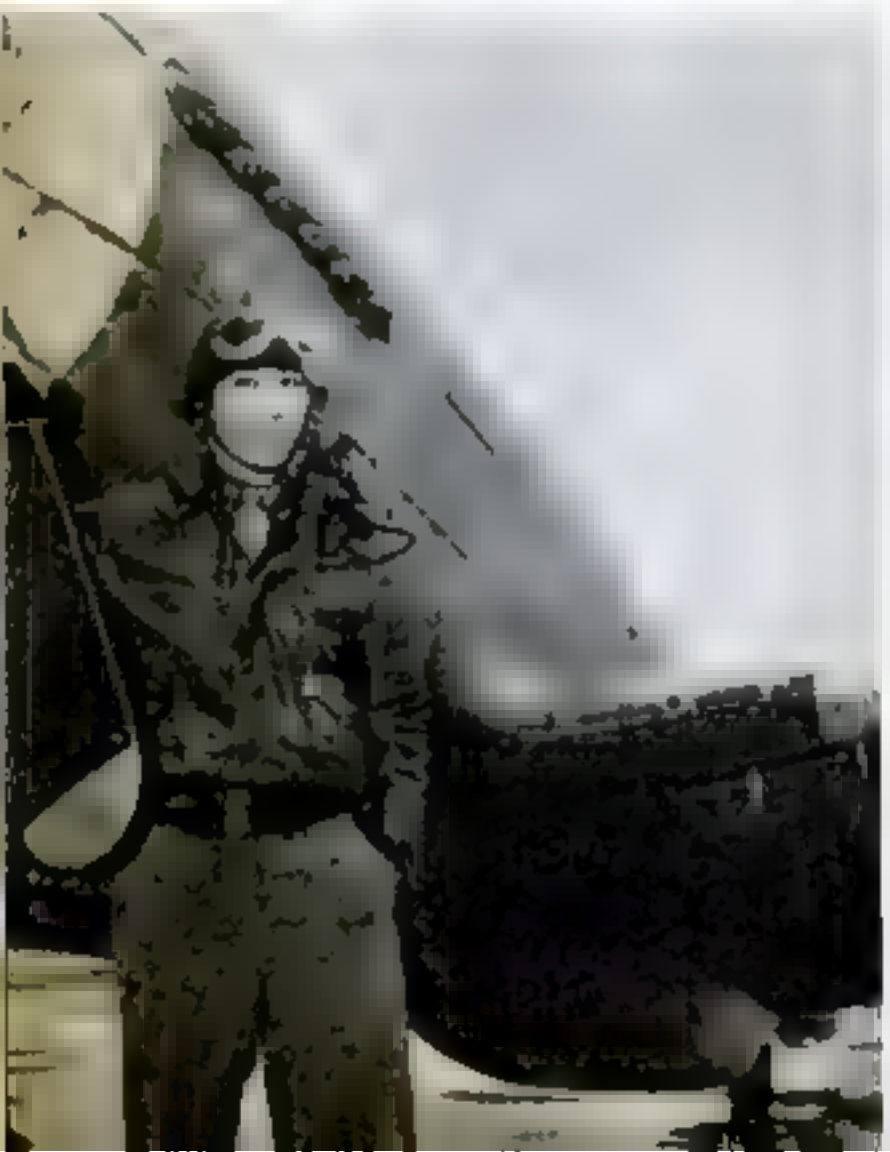
Original commander of Howard's group was Col. Kenneth R. Martin, who was lost in the February 11 raid on Frankfurt. He was the inventor of a rack of glass shelves on which model planes can be placed to illustrate air tactics

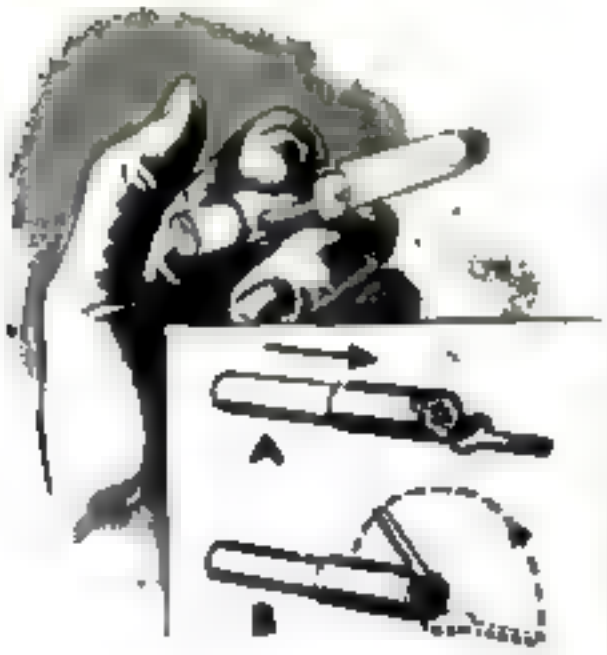
III

The Mustang is a product of North American Aviation, Inc., but to a great extent we owe it to the British. The first military plane to be developed in America during the present war, it was first manufactured in November 1941, in response to a request from the RAF for a fast, low-flying fighter, to be used by the Army Co-operation Command. Driven by a 1,150-horsepower Allison engine and designed for extremely low flying, the original Mustang soon made a name for itself as a rhubarb plane, busting trains with four 20-mm. (*Continued on page 124*)

Flying a Mustang known as "No Tichee No Washee," Lt. Wah Kan Kong, from Honolulu, called himself the best-looking Chinese fighter pilot in the entire ETO—meaning that he was the only one

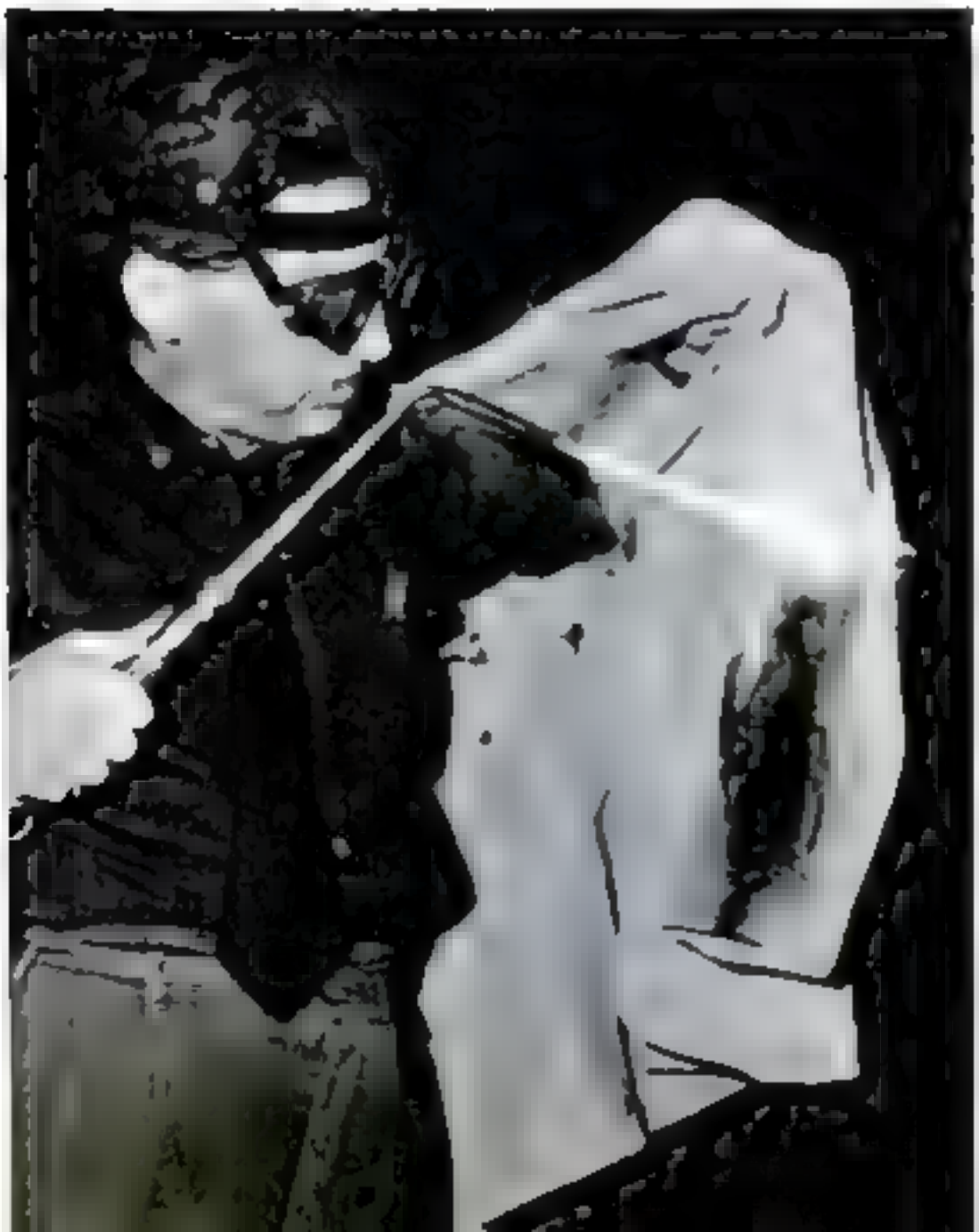
Kong was flying on the wing of his squadron leader, Jack T. Bradley (below), when they jointly destroyed a Messerschmitt. After the Chinese pilot scored hits, his plane exploded. Bradley, from Brownwood, Tex., is now an ace





A SNUFFER to prevent fires caused by cigarette smokers consists of a sliding band of fire-resistant material that fits around the cigarette and a lid that can be closed over the lighted end. To lay the cigarette down without danger of the burning tobacco starting a fire, the band is slid over the ignited portion. To extinguish the cigarette at any time, the cap is closed and held tight by a tab that fits into a slot in the band. The tab also serves as a handle for sliding the band, and the band protects the smoker's fingers from staining. Anthony J. Miliett, of Shaker Heights, Ohio, invented the extinguisher.

"BATTLE" STAINS are applied deliberately to costumes worn by actors in war films. It looks like sabotage to treat military uniforms this way, but it is really economical. Always ingenious, Hollywood wardrobe artists use a blowtorch to simulate the dirt and stains of mechanized warfare in order to conserve clothing. The carbon in the flame blackens the surface of the material without destroying the fibers. Hence, a costume worn in a combat scene in one picture can be cleaned and used for a dress parade in the next picture. Real battlefield grime is harder to remove.



SKELETON IN SPLINTS shows the varied applications of a new reduction and fixation splint being used by the United Nations armed forces and soon to be available for civilian use. An adjustable connecting bar joins two half-pin units and bridges the fracture. No extension apparatus, special frame or fracture table, or plaster cast is needed with this light, compact device. Its inventor, Dr. Otto Stader, University of Pennsylvania veterinary surgeon, has been awarded a $1,000 prize and a medal.

OBSERVER

PILOT

OFFICER'S CAP DEVICE

SERVICE BARS

1,000 HRS.+2 YRS.

500 HRS.+1½ YRS.

250 HRS.+1 YR.

SHOULDER PATCH

NON-COMMISSIONED OFFICERS

CIVILIAN DRESS INSIGNIA

C.A.P.

OFFICER'S COLLAR DEVICE

GARRISON CAP DEVICE

DUCK CLUB

Identifying the Men Who Guard Our Home Skies

INSIGNIA of the U. S. Civil Air Patrol, an auxiliary of the AAF, are worn by 100,000 volunteer men and women serving either as pilots or as experts in allied fields. To date, CAP has reported 173 enemy subs and sunk two on its own hook Over 30 members have been lost in active duty and two have received the Air Medal.

ACTIVE-DUTY INSIGNIA

COAST PATROL

LIAISON PATROL

FOREST PATROL

COURIER SERVICE

CADET SHOULDER PATCH

17-YEAR-OLD AIR CORPS ENLISTED RESERVISTS TRAINING IN THE CIVIL AIR PATROL

He's Deadly . . . Swat Him!

CARRIER of such dreaded diseases as cholera, typhoid, dysentery, and enteritis, and now suspected of also transmitting infantile paralysis, the common housefly is our insect public enemy No. 1. The model above, fashioned in wax and glass by the Polish artist Ignaz Matausch and now on exhibit at the American Museum of Natural History, New York, shows the six hairy legs on which the fly carries the germs that he picks up from excrement and other types of filth.

When peace comes, the new insecticide DDT (P S.M., June '44, p. 56A), now preempted for use in bug-ridden battle areas, will help to decimate this dangerous pest. Until then our best defense is to make proper disposal of all decomposing materials, to trap these insects with flypaper and other means, and to "swat that fly" whenever we can.

Flies breed fast. A pair hatched in April will have millions of descendants in August

HOW TO USE A FLY SWATTER

Aim a half an inch behind him. Because of the construction of his legs, he has to take off backward before he can start to fly forward

A few chemically inert particles known as "boilexcrt" will suffice to prevent liquids in flasks or test tubes from boiling wildly. Tiny streams of vapor will rise steadily from hundreds of points on these particles, rather than create a dangerously fast geyser

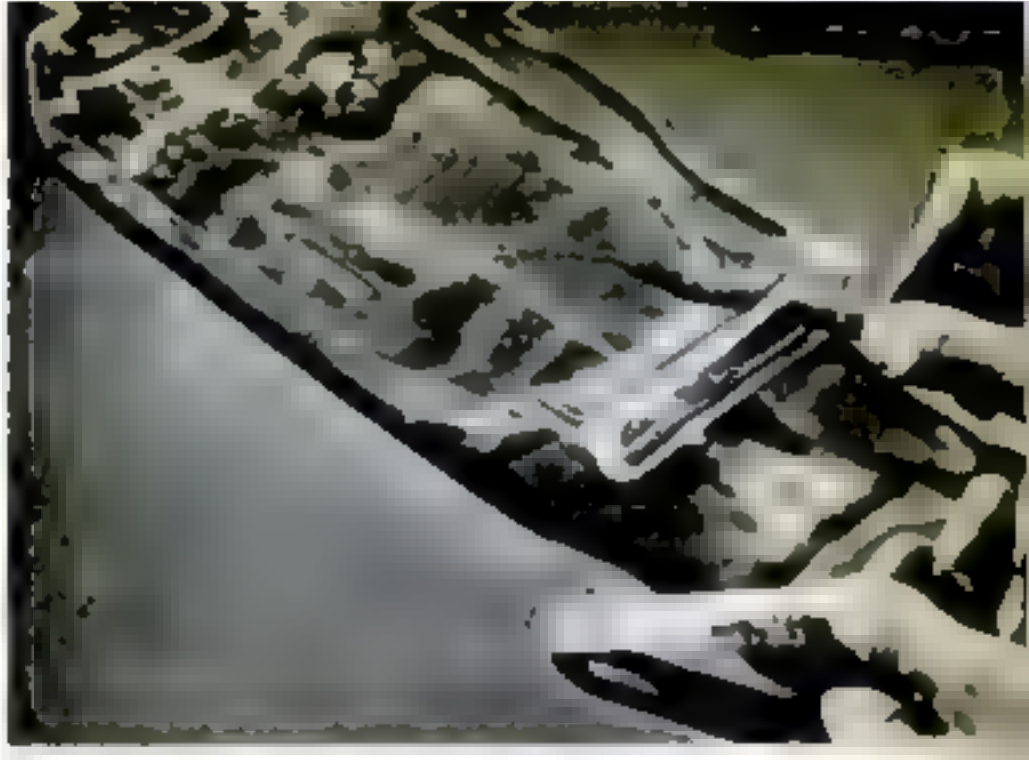
BUBBLE-TAMING PARTICLES of chemically inert material may be obtained now by home chemists and industrial researchers to prevent boiling action from becoming too furious. These particles may be put in low-boiling liquids such as acetone and alcohols.

Without them, when considerable liquid becomes volatile at the same instant, it may gush up in a geyser (as shown above at the left). Thus a test tube may erupt, or the contents of a distilling flask may surge over into the distillate. This can be avoided by putting particles into the vessel that will provide hundreds of tiny points from which streams of vapor bubbles may flow evenly to the surface.

Hollow glass beads, which were formerly used for this purpose, are no longer available, and marble chips, which are sometimes used, are attacked by many chemicals. But new particles have been produced that resist almost all chemical action except that of concentrated sulphuric acid and strong alkalies. They do not contaminate a distillate because they are completely nonvolatile. Three or four are enough to quiet action in a test tube

COOKING WITH MAGNETISM has been found fast and economical in the Connecticut home of O. H. Caldwell, New York editor and radio commentator. Sixty-cycle magnetic pulsations from the open ends of transformer cores surge through iron pole pieces in the bottom of the pan, causing eddy currents that heat the utensil's contents but not the stove top. Caldwell has used this method for three years

1 Contents of a bottle of penicillin culture medium, consisting of sugar, yeast, and other ingredients that have been found favorable to growth of penicillium, are put into a liter of distilled water. The flask and the medium are then sterilized



2 Next, a portion of the penicillin medium is poured on gauze pads in a Petri dish, or into this special flask, and the surface of the pads or medium is inoculated with spores of green *Penicillium notatum* mold

New Method Boosts Penicillin Supply

NEW equipment permits production of "crude" penicillin (P.S.M., Dec. '43, p. 83) by a simple laboratory technique. This method is not intended for home use or where facilities are inadequate. The product, less concentrated and pure than that of big fermentation plants, cannot be used for intravenous injections, but may be applied advantageously to surface lesions by means of gauze dressings or drops.

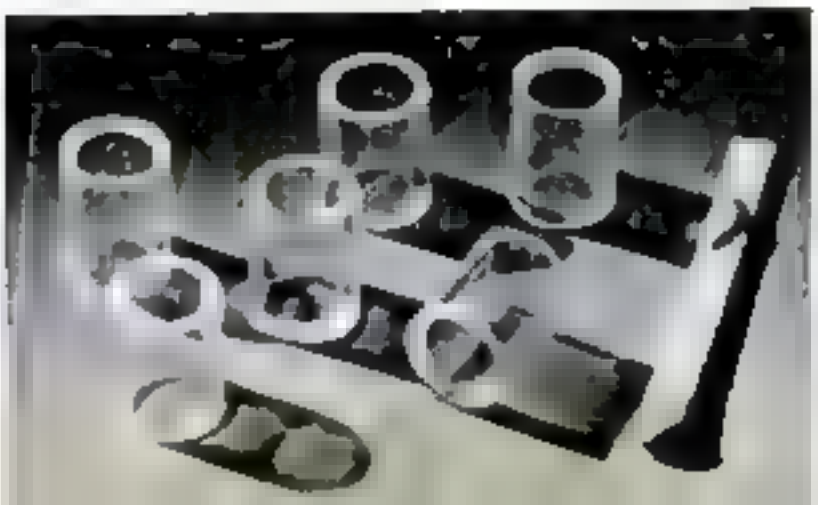
Penicillin is a by-product of the fungus *Penicillium notatum*. This mold can be grown on the surface of a special culture medium containing nutritive elements. It is dissolved in water, sterilized, and poured on squares of gauze or into a new penicillin culture flask that gives the mold a large growing surface. The gauze or medium is inoculated with spores of *Penicillium notatum*. Tiny drops of penicillin form on gauze in a few days, and this gauze may then be used while penicillin production is at a peak. In the flask, penicillin dissolves in the medium, and the whole solution is used for drop applications. Time for producing the drug may perhaps be cut through a process, announced by Dr. Baruch Levin of the Hebrew University in Jerusalem, which is said to require only about an hour.

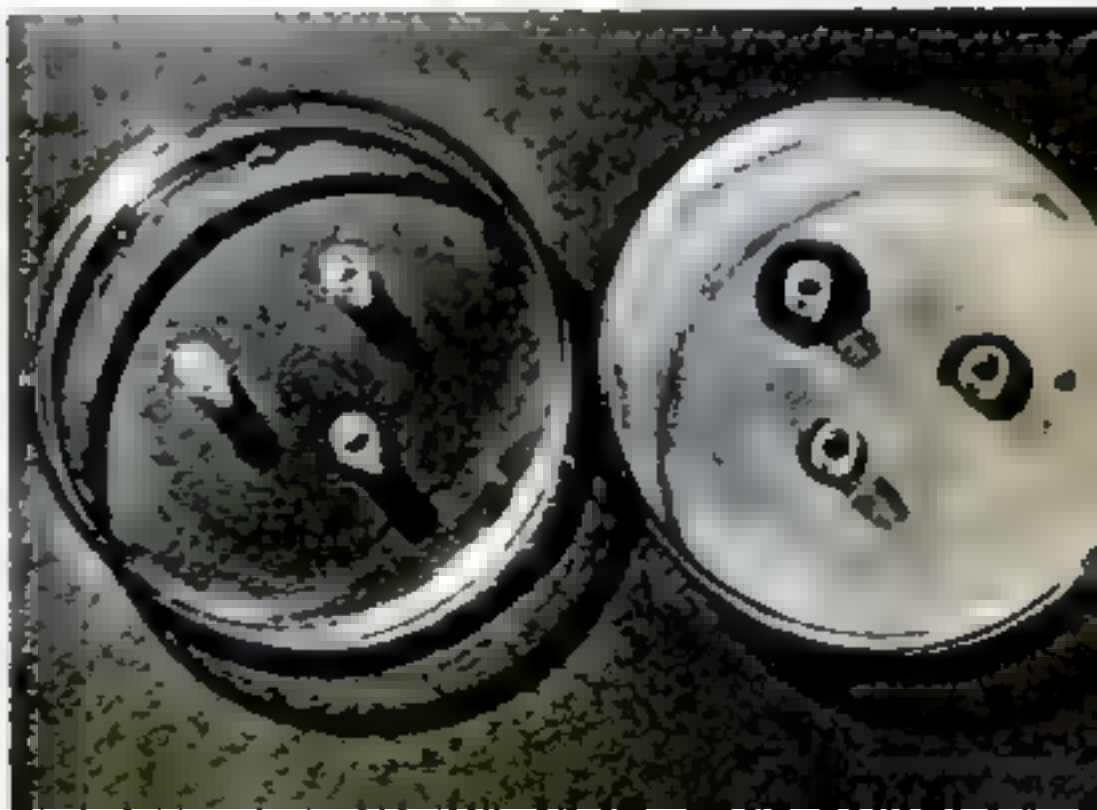
3 Penicillium grows at room temperature. Mold starts to appear in 24 hours. Gauze may be used in four or five days. Penicillin in flask may be used in 12 days

The drug's potency is revealed by "penicylinders," glass tubes placed on an agar plate containing *Staphylococcus aureus*.

THIS SIMPLE TEST REVEALS THE STRENGTH OF THE DRUG

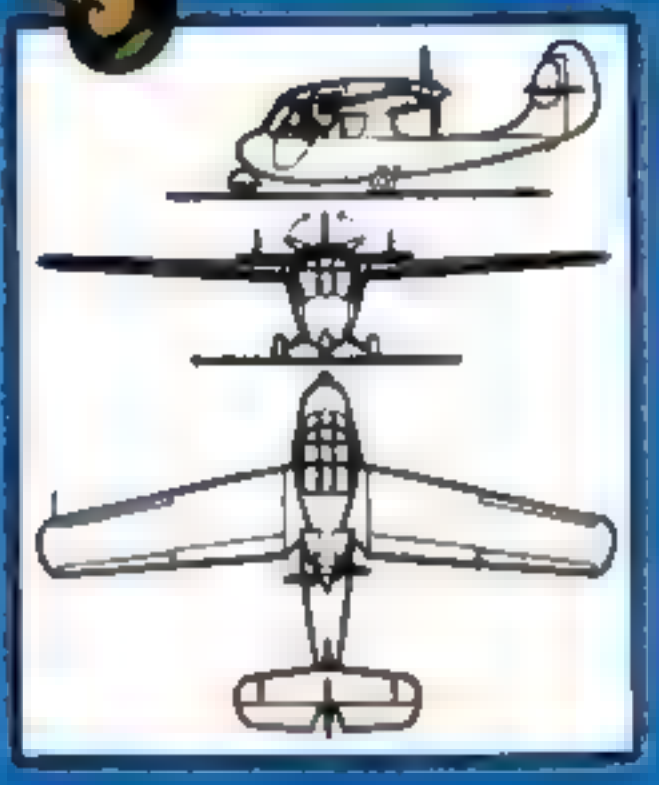
"Penicylinders" measure penicillin's potency. Sharpened ends of these tiny tubes are put on the agar plate, penicillin is placed in the tubes and incubated at 37 degrees centigrade from 12 to 16 hours. Bacterial growth is inhibited in a zone around each cylinder, depending upon the strength of the sample used

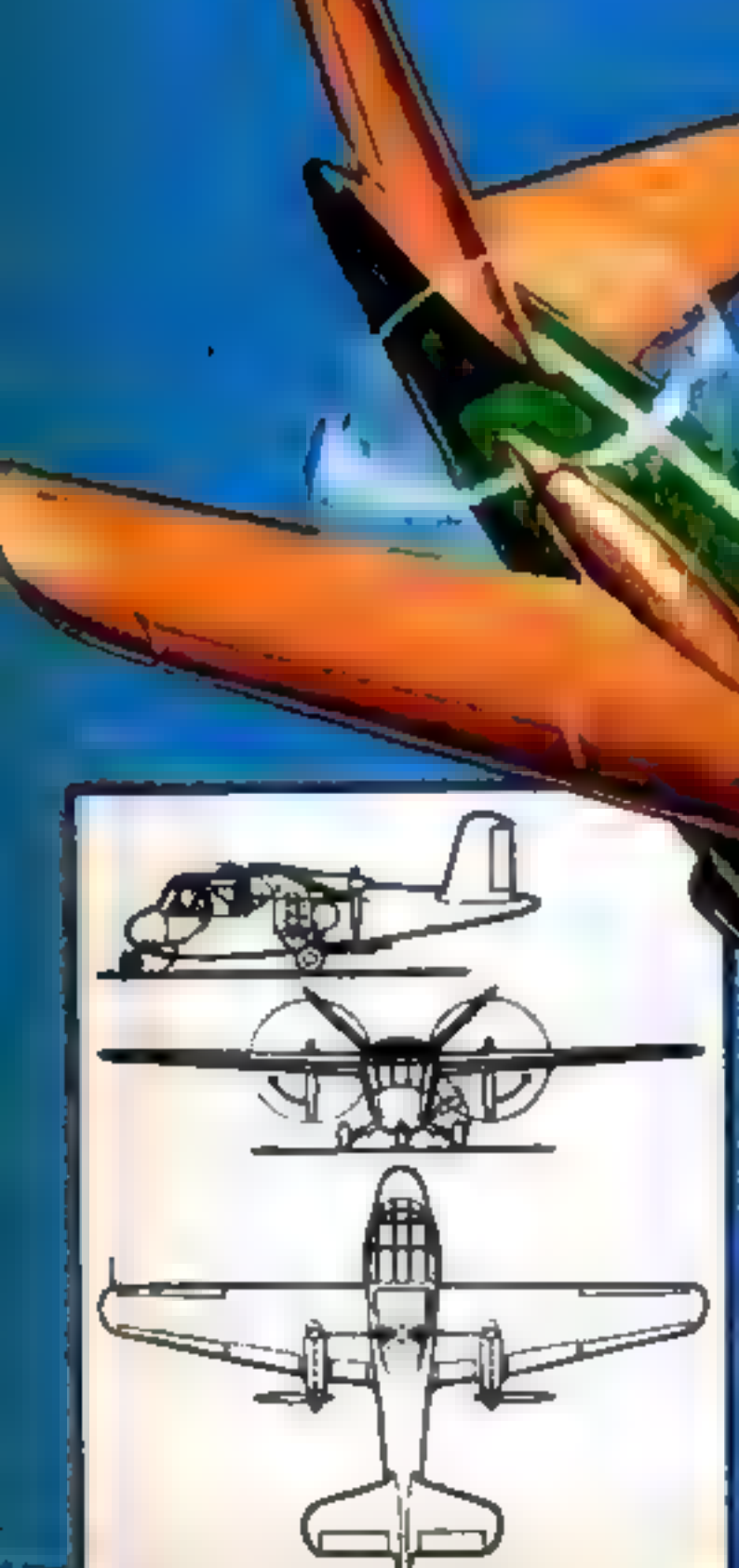




Short Range IDEAS FOR
PRIVATE PLANES OF THE FUTURE

What Are Your Ideas?





YOU now have little time to waste if you are going to enter our $5,000 contest on "The Plane You'd Like to Own" and try for one of the many generous War Bond awards. The closing date is September 30.

In a competition as important as this one, when you are going to pit your wits against a number of other readers, you shouldn't feel you have to work hurriedly. Give yourself a fair chance—lots of time to think over your ideas and plenty of leisure to write your letter and make any sketches in the clearest, simplest form.

That's all there is to the contest, as you will see if you read carefully the rules on the following page. You will also find on page 123 some suggestions on helicopter design If you study those drawings together with the great variety of information we have given in the contest announcements published in the June and July issues, you have all the hints we can give you on the preparation of an entry that will have a good chance of winning one of the prizes.

To insure the utmost fairness and impartiality in conducting the competition, it will be supervised by the following Contest Committee:

Lt. Col. Charles Wayne Kerwood, AAF, famous World War I combat pilot.

Capt. Don F. Smith, USN, director of Naval Air Transport Service and a great Navy pilot. *(Continued on page 123)*

Enter our $5,000 Contest for the best letters on "The Plane You'd Like to Own"

All you have to do is write a letter describing what you think the postwar air flivver should be like . . . Everyone has a chance to win one of the many War Bond awards . . . There's a separate advanced class, too, for experts.

AWARDS TOTAL $5,000 IN TWO SEPARATE CLASSES

PROFESSIONAL
For Aviation Engineers, Designers, Draftsmen

FIRST PRIZE	$1,000 War Bond
SECOND PRIZE	500 War Bond
THIRD PRIZE	300 in War Bonds
FOURTH PRIZE	200 in War Bonds
FIFTH PRIZE	100 War Bond
SIXTH PRIZE	50 War Bond
SEVENTH to TWENTIETH PRIZES $25 War Bond each	350 in War Bonds

NONPROFESSIONAL
For General Readers

FIRST PRIZE	$1,000 War Bond
SECOND PRIZE	500 War Bond
THIRD PRIZE	300 in War Bonds
FOURTH PRIZE	200 in War Bonds
FIFTH PRIZE	100 War Bond
SIXTH PRIZE	50 War Bond
SEVENTH to TWENTIETH PRIZES $25 War Bond each	350 in War Bonds

BETTER VISIBILITY is the outstanding feature of these two and four-place planes, conceived and drawn by staff artist Rouse. In the two-place model, the sides, by sloping inward at the bottom afford better downward visibility and excellent forward visibility. Luggage space is ample, and the propellers rotate in opposite directions to counteract torque. The four-place version also has counter-rotating props, and tricycle landing gear on both models affords better visibility by keeping the ships level when grounded. Both planes also carry flaps and slats for increased maneuverability

$5,000 PLANE CONTEST

Rules

THE purpose of this contest is to encourage interest in aviation in general and aircraft design in particular through serious consideration of America's private planes of the future. For the purpose of this contest the helicopter may be regarded as a private plane.

Contestants will submit their ideas as to the appearance, size, equipment, and performance of the private plane that would find the greatest postwar market among the thousands of prospective pilot-owners.

The contest is open to all except employees of Popular Science Publishing Co Inc and their families. Entries will be divided into two classes. The professional class will be open to those who have had training, or who are now receiving training, in aviation engineering, aircraft design, or aircraft drafting, or who are now employed or have had experience in any of these three types of work. The nonprofessional class will be open to all others. Members of the nonprofessional class may submit entries in the professional class if they wish, but professionals will be limited to the professional category. Only one entry may be submitted by a contestant. Identical prizes will be awarded in [illegible] classes.

Professional-class entries will consist of at least a "three-view" drawing (front, top, and side elevations) of the proposed future private plane plus a descriptive letter of not more than 1,000 words about the plane and its theoretical performance, dimensions, equipment, and so forth.

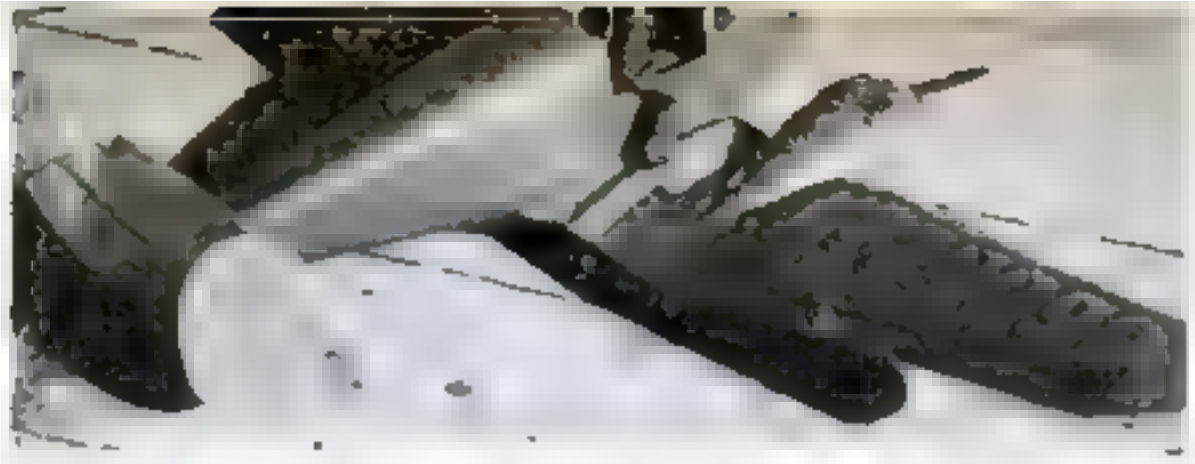
Nonprofessional entries will consist of a letter of not more than 1 000 words describing the proposed plane. If desired, you may include a sketch or drawing of the plane in pencil or other medium.

Entries will not be judged upon writing ability craftsmanship, or decorative appearance Only the soundness, practicability originality, and merit of the ideas will count. Nonprofessional entries must be accompanied by a signed statement that the contestant has never been employed in, has not had training in, and is not now receiving training in aviation engineering, aircraft design, or aircraft drafting.

Entries should be mailed flat and must be fully prepaid. Each entry must be plainly marked with your name and address and the class in which the material is to be entered. (Please typewrite or print this information on each item or page of your entry.) Also state your occupation and the position held. Address Plane Contest Editor, Popular Science Monthly, 353 Fourth Ave. New York 10 N Y The contest will close Saturday, September 30, 1944, and all entries must be postmarked on or before that date.

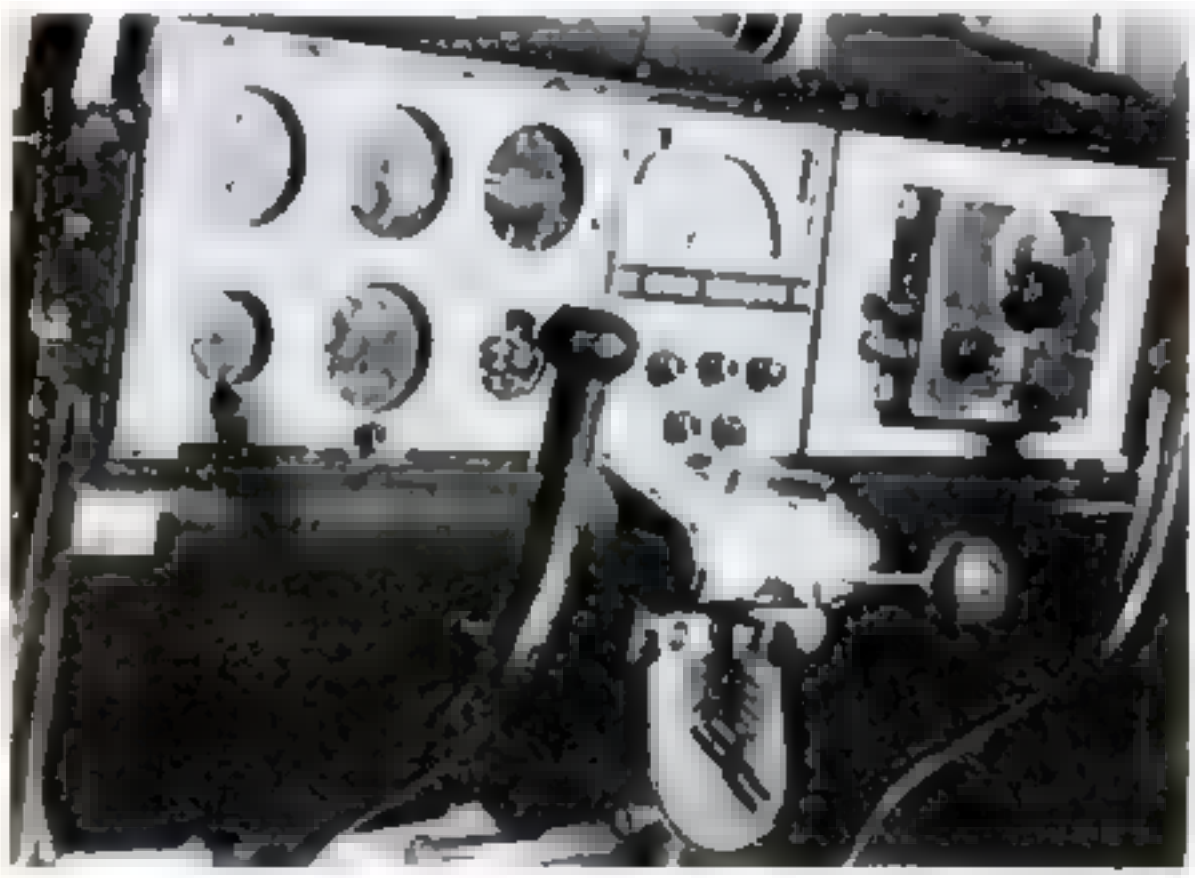
All prize-winning entries will become the property of *Popular Science Monthly* for publication. However, contestants will retain the right to make any commercial use of their designs they wish. No entries will be returned, so make a copy of your entry or have it photostated if you want to keep it for future reference.

The board of judges consists of five prominent aviation authorities who are widely recognized as outstanding leaders in their individual fields and two editors of *Popular Science Monthly*. The decision of the judges will be final. In case of ties, the tying contestants will receive identical awards. All contestants will be informed by mail as to the winners as soon after their selection as possible.

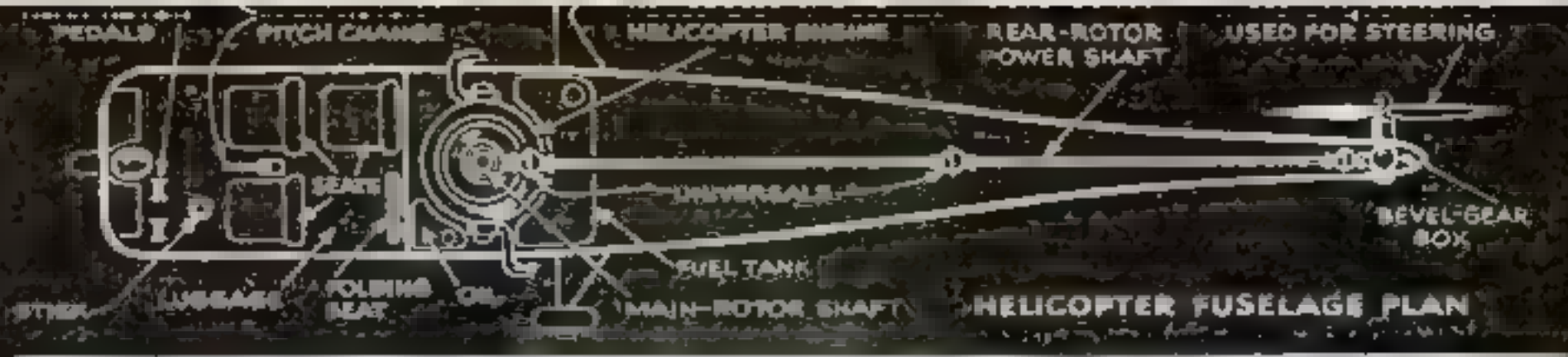


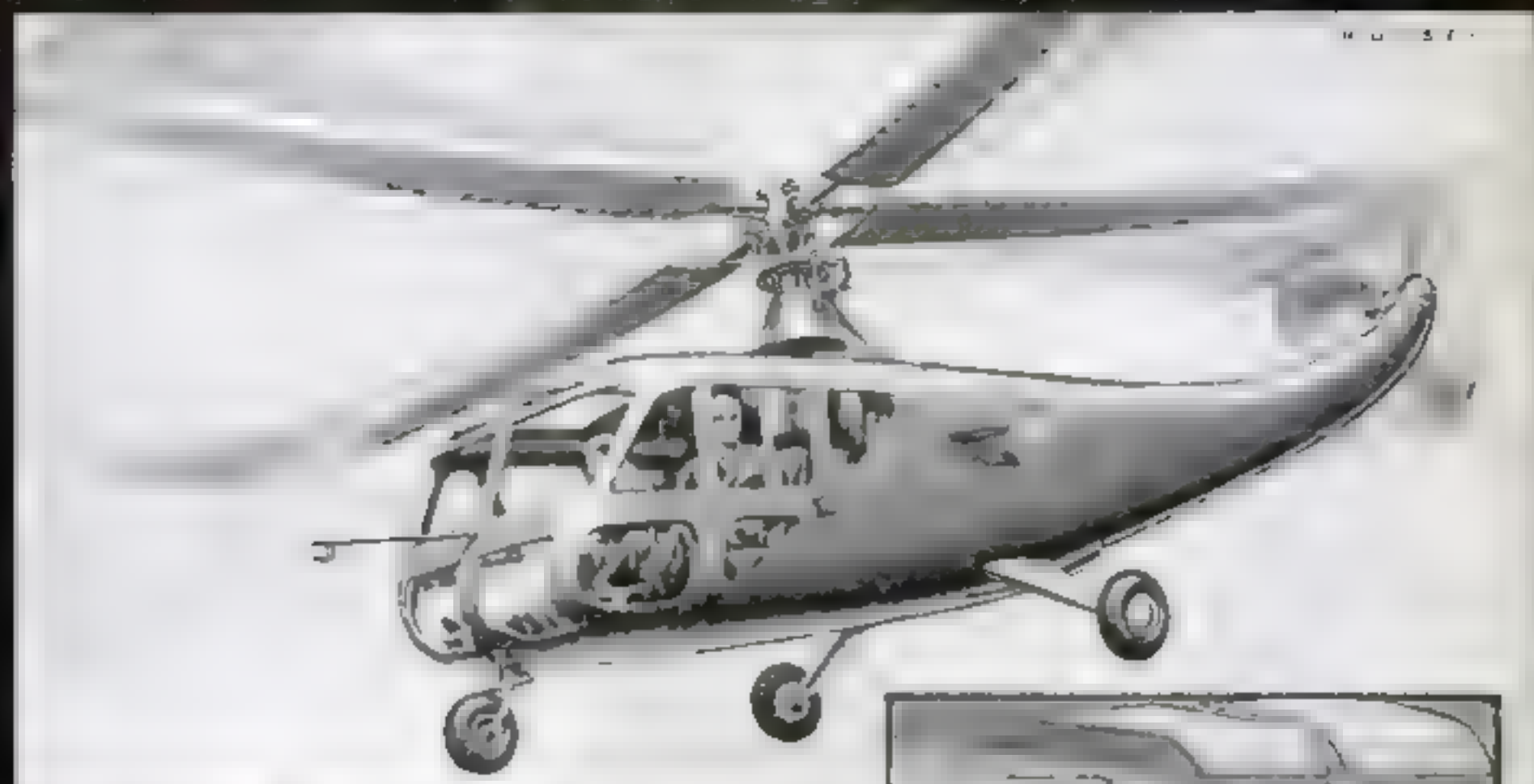
THIS ALL-PLASTIC-PLYWOOD LANGLEY is representative of the prewar trend in new materials for private planes. A four-place ship, it has two 90-hp. Franklin engines that give it a top speed of 165 m.p.h. and a cruising speed of about 150

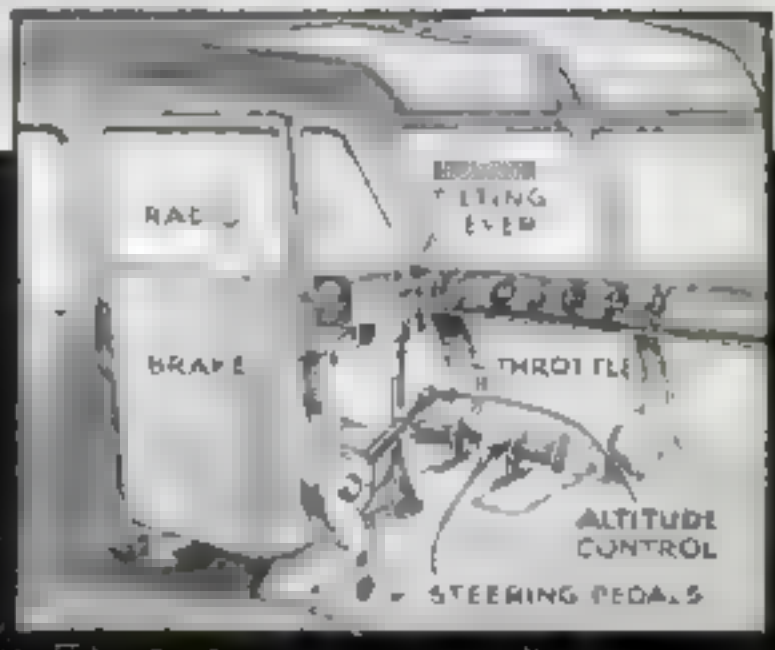
GOOD AND BAD VISIBILITY. The low instrument board (at left) and a tricycle landing gear make it easier for the pilot to see. A high board (right) and conventional gear (which lifts the ship's nose when plane is grounded) limit the pilot's vision



PANELS are now being designed to look like automobile dashboards. In fact, the entire interior of the modern private plane is being done in the colors and materials that car owners have found so attractive and durable







In these drawings by staff artist Rouse you will find some tips that may help you in making your own helicopter design. For instance, in the plan at top, note how one of the seats folds down to make room for luggage. Also how the placing of the dashboard (at lower right) makes for better downward visibility—important in a plane that can descend vertically. The landing-gear plan suggests the best type for helicopters

William T. Piper, president of Piper Aircraft Corp.

Harlan J. Maynard Jr., president of General Aircraft Corp.

Roscoe Turner, noted racing and stunt pilot

T. Claud Ryan, president of Ryan Aeronautical Corp.

Ruth R. Nichols, famous woman pilot.

C. S. (Casey) Jones, president of the Casey Jones School of Aeronautics.

James C. Hart, president of Taylorcraft Aviation Corp.

Alfred B. Bennett, director of sales, Aeronca Aircraft Corp.

L. Welch Pogue, chairman of the Civil Aeronautics Board of the Department of Commerce.

John E. P. Morgan, manager, Personal Aircraft Department, Aeronautical Chamber of Commerce of America.

This committee is serving in an advisory capacity. The actual judging of the entries will be in the hands of the distinguished Board of Judges announced last month.

Better start getting your entry ready!

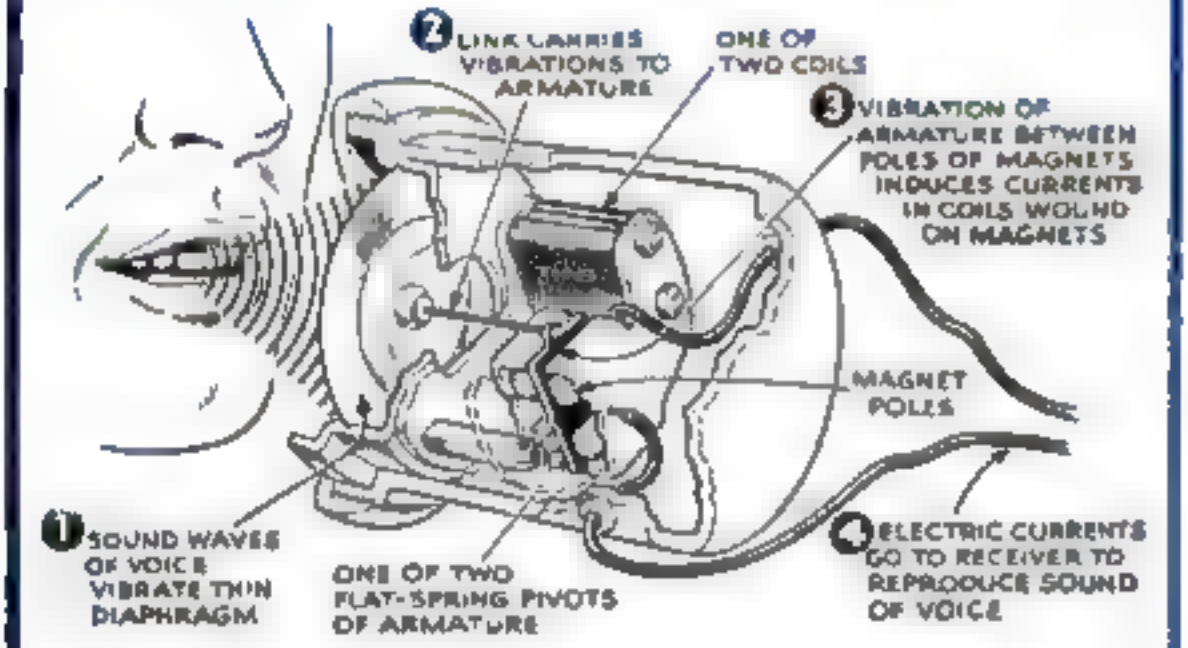
Sound-Powered Phones Carry Battle Orders

VITAL wartime needs have been met by the amazing sound-powered telephone developed by the Bell Telephone Laboratories. Based on well-known telephonic precedents, the device is a novel one in that the voice of the speaker generates the necessary electric current. Precision in its rugged construction has enabled it to withstand such tests as slamming against steel plates and subjecting it to concussion from the firing of heavy ordnance. The instrument is not much larger than the usual home or office phone.

With ordinary land wires, it proved one of the most useful pieces of Signal Corps equipment on Guadalcanal, where it has been effective over distances of from five to 10 miles. It is used on all Navy ships and most freighters. Added to its efficiency are the advantages of being considerably smaller, more compact, and more durable than battery-powered telephones.

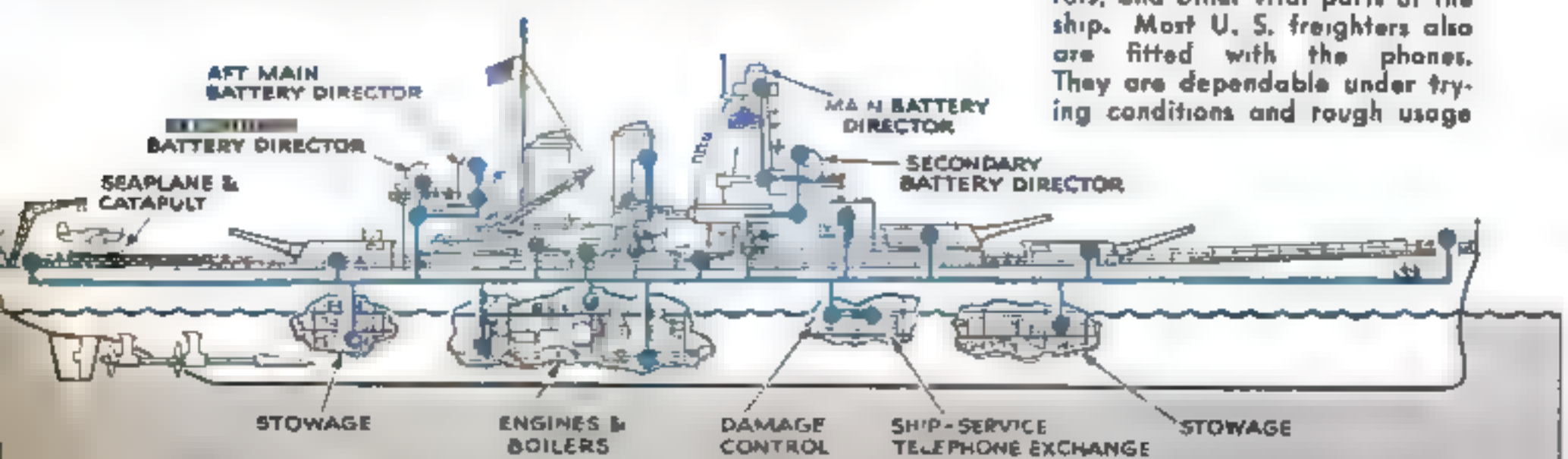
Although the energy in human speech is slight, it is so well employed in this phone that as many as 20 persons at various points in a warship can hear one talker. Development was begun more than 10 years ago to fill the need for a dependable battle communications system to replace the cumbersome maze of speaking tubes then in shipboard use. At a forward observation post, no bell need ring when you make a call. You simply whistle into the transmitter.

A U. S. Navy seaman finds the range for the gunners on an escort aircraft carrier and uses the new sound-powered telephone to communicate the information to the gunnery officer concerned



HOW THE SOUND-POWERED PHONE WORKS

SPEAKING into the telephone vibrates the diaphragm. Motion is carried to the armature by the driving link, causing it to swing like a seesaw on its central pivots inside the coils of wire surrounding it. This induces voice-frequency electrical currents in the coils, and these go out to the receiver, where the operation is reversed and the currents are converted into speech.



TYPICAL installation of a sound-powered telephone system on a battleship. The phones link the bridge, conning tower, battery directors, engine room, gun turrets, and other vital parts of the ship. Most U. S. freighters also are fitted with the phones. They are dependable under trying conditions and rough usage

Two men can launch an antiplane kite in 10 or 15 minutes. The fabric is unfurled (1) and the 20 pieces are put together (2). Sailor puts in struts and the guideline is made fast (3). Men toss assembled kite from deck of the ship (4), and line is paid out from a winch (5) as it rises over the mast (6) to ward off enemy planes with its wing-shearing, propeller-fouling cable

"Barrage Kites" Shield Convoys

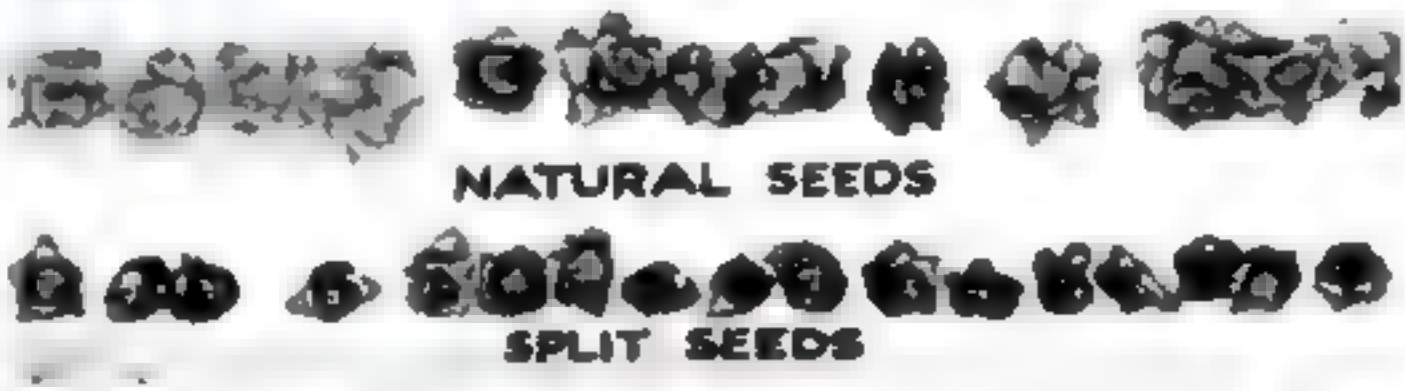
KITES now comb the sky above our merchant ships, flying in the paths of attackers the same kind of wire that is used on barrage balloons. The wire is invisible from a plane, but it will rip off a wing or foul a propeller. Knowing that, enemy airmen keep their distance. A kite is easier to launch and maneuver in a high wind than a balloon, does not show a strip of wire so much, and costs less—$108 as compared with $1,200 for a balloon. The box kites used are made of aircraft fabric, with spruce struts and 2,000-foot lines. W Bsn. H. C. Sauls, of the War Shipping Administration, experimented 12 years to perfect this type of kite, which was intended originally for displaying advertising signs. The Navy adopted it in 1941. Since then more than 1 000 officers and seamen have been taught its use at the U. S. Maritime Service Kite and Barrage Balloon School in New York.

March of Science

A machine that saves 3 000,000 man-hours a year by separating five-segment sugar-beet seeds into singles. An abrasive wheel forces seeds against shearing bar to make the division

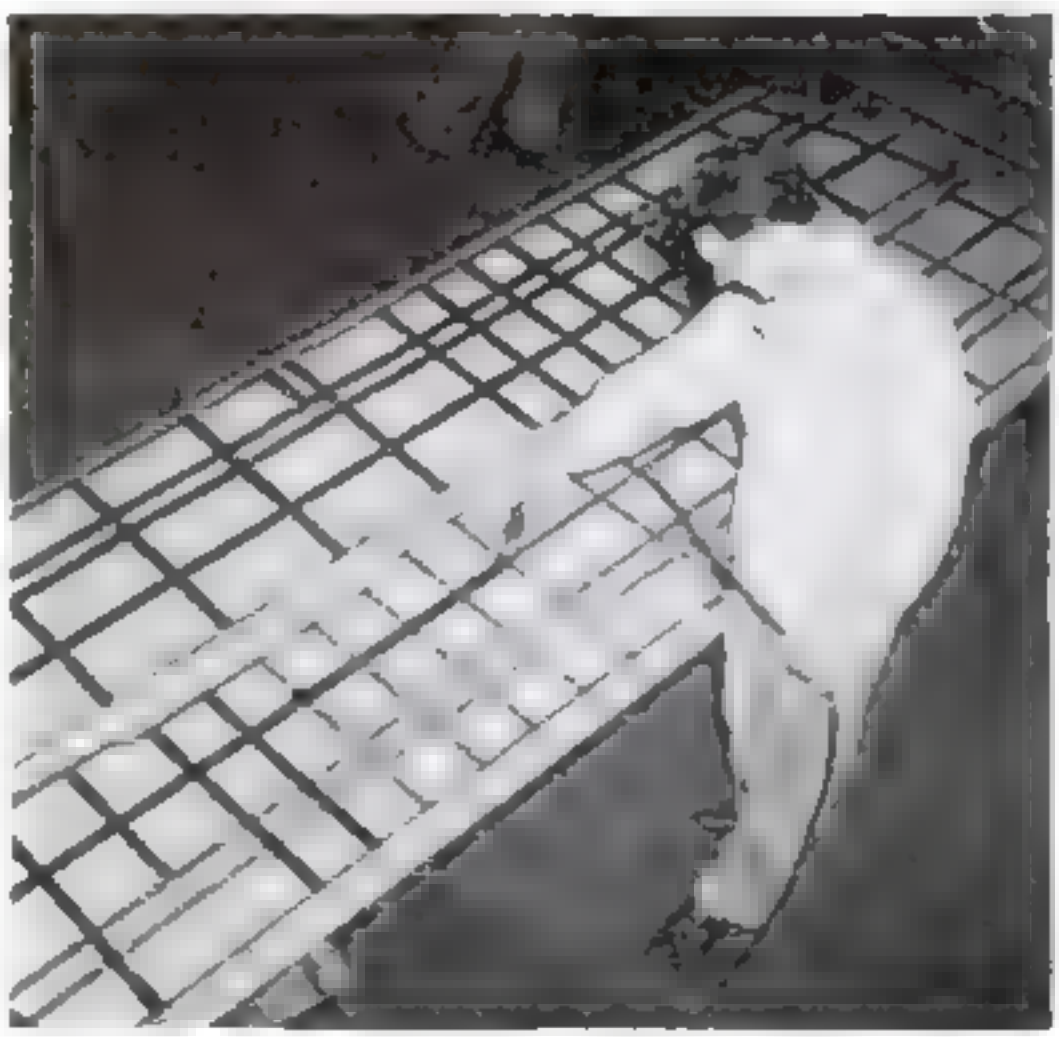
AGRICULTURE

MILLIONS OF MAN-HOURS are being saved every year in our sugar-beet fields through the use of a machine developed by Prof. Roy Bainer, of the U. S. Department of Agriculture, for breaking up the clusters of beet seeds. The machine separates the seeds along lines of natural cleavage without impairing their fertility. Single seeds, delivered undamaged from the machine, serve to plant five times as many acres as the composite seeds heretofore used, thus increasing the available supply. Saving of time and labor is effected by eliminating the need for hand thinning out of sprouting clumps.



INDUSTRY

"GUNK" is what workers in the Chrysler Corporation factory call their superglue named Cycleweld. It is a rubber-and-plastic cement that makes virtually inseparable bonds between metal and plastics, wood, or other metal. In the latter use it partially supplants riveting, eliminating as many as 900 rivets in a wing flap for a fighter plane and producing a lighter, stronger structure. It can be brushed or laid on in the form of tape. The picture shows a workman applying tape to the skin of a wing flap.



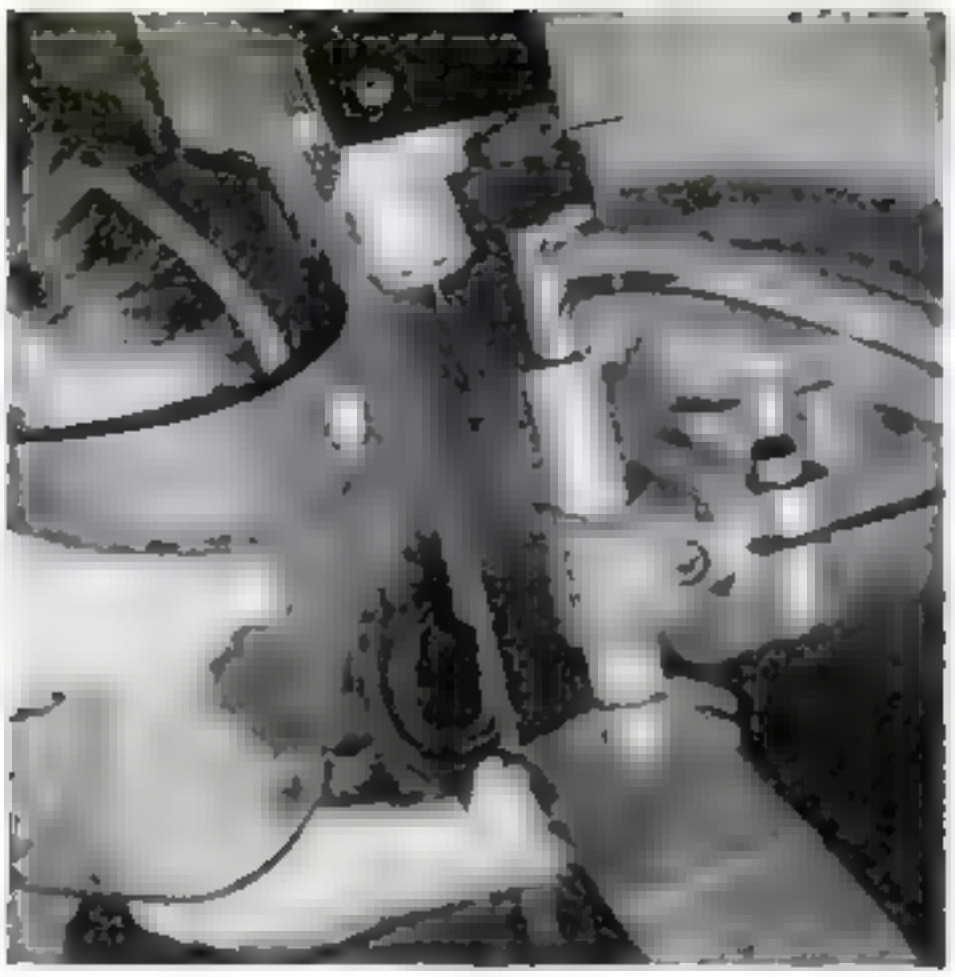
MEDICINE

A SIREN WAILS when this surgical instrument locates metal in a patient's body. By the addition of the audible signal to his already efficient electric probe, Samuel Berman, New York transit system engineer, has produced an improved device for dealing with battlefront casualties involving wounds from shrapnel or other pieces of metal. Berman's original model, first used at Pearl Harbor, employed a swinging needle to indicate when an exploring coil passed over a deep-lodged piece of steel (P.S.M., May '42, p. 124). With the siren attachment, a surgeon can tell, without looking up, how close he is to the metal. In the photograph at the right, a nurse is using a transparent plastic model of the human body to show the operation of the probe.

HE GUINEA-PIGGED HIMSELF. By inoculation with a virulent culture and subsequent dosing with vivicillin, Dr. Hans Enoch, codiscoverer of the drug, proved its efficacy. He is pictured here in his laboratory at Hendon, England. Related to penicillin, the other curative agent derived from mold, vivicillin has saved the life of a boy whose tendency toward bleeding made removal of a diseased appendix out of the question. A girl with mastoiditis was cured by four doses of vivicillin. Its sponsors describe it as better than penicillin in some cases but not as good in others; with wider experience in its use, the two drugs should offer a choice of the more effective for a particular case. Another new drug of similar type is chlorellin, obtained from fresh-water algae—microscopic green plants that require no artificial nutriment for cultivation.

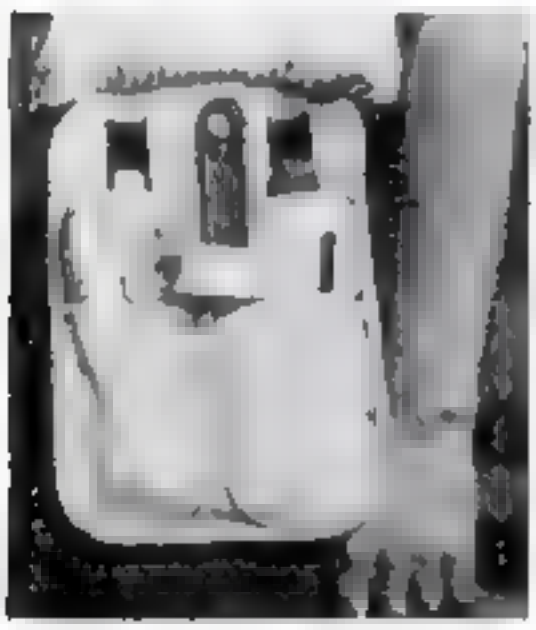
BACTERIOLOGY

MEDIEVAL weapons inspired this modernized crossbow of flexible steel devised by Westinghouse research engineers to draw out molten quartz into filaments 1/30,000 inch thick (1/60 the diameter of a human hair) for measuring the magnifying power of the electron microscope. With the bow stretched, a cylinder of fused quartz is attached to the "arrow" and heated to the melting point. Then the operator pulls the trigger.

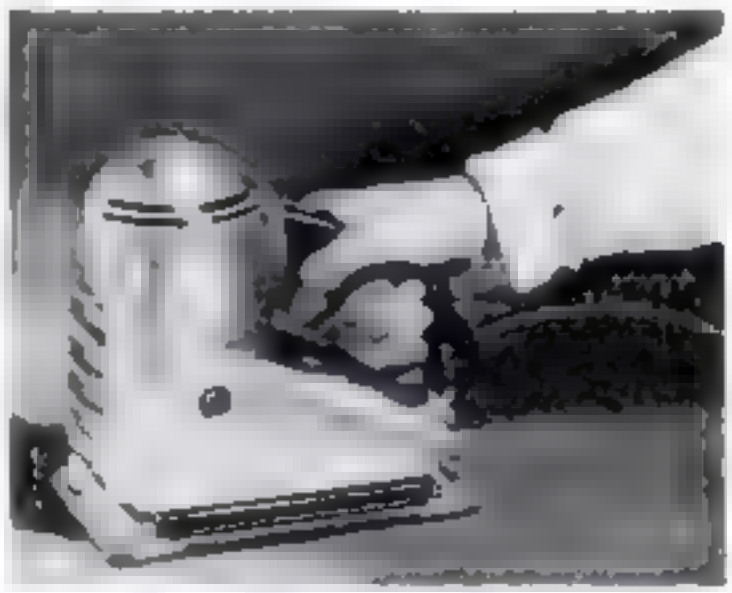


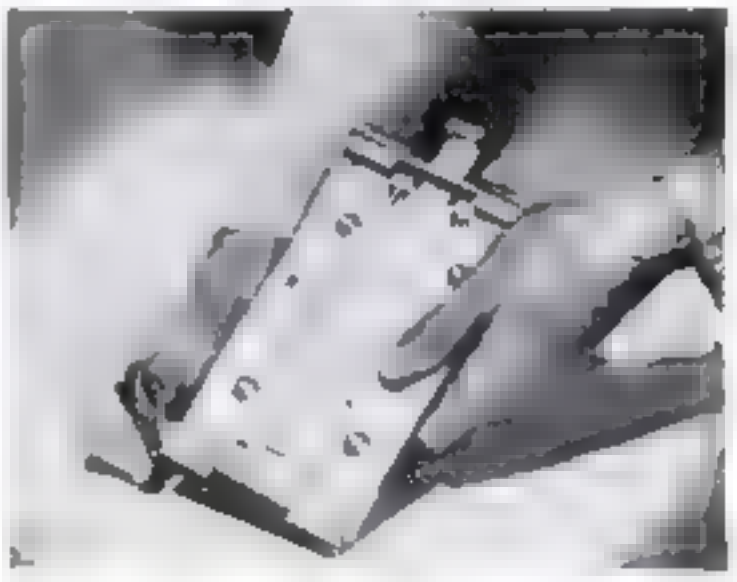
NEW Tools

PINHOLE SPOTLIGHT is a new device for increasing welding speed on combat planes and other war equipment. Originated by A. B. White, research engineer for the Westinghouse Electric and Manufacturing Company, this pinhole lamp throws a tiny beam on the tip of the copper electrode of a resistance welding machine, and shows the operator the exact spot at which the weld will be made before the copper rods clamp together to "sew a stitch" with electricity. Thus the operator can space his welds evenly.



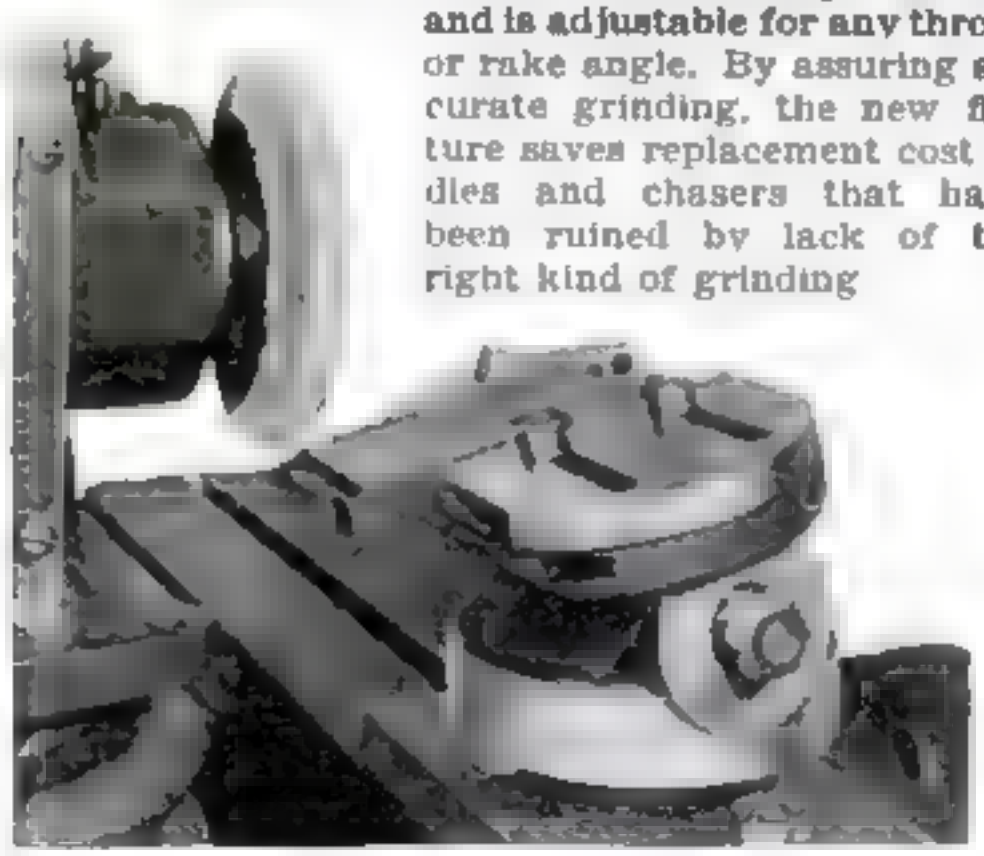
NEW HIP KIT for tools replaces sagging apron holders. Worn on the belt and made of soft chrome-elk-tanned cowhide, the kit holds tools securely, permits easy access to them, and does not hamper the movements of the worker. It is made by the E. F. Hillegas Co., Glendale, Calif.





DETACHABLE PADS make it easy to reload a new electric portable sander made by the Sterling Tool Products Company, Chicago, Ill. The flexible sanding pad used is detached from the machine by the pulling of a latch, and another is substituted quickly from the supply kept at hand. Although the pad moves at a speed of 4,500 oscillations a minute, vibration in the holder is scarcely perceptible.

A CHASER GRINDING FIXTURE, introduced by the Oster Manufacturing Company, Cleveland, Ohio, is designed for easy mounting on the table of any conventional tool and cutter grinding machine, and is adjustable for any throat or rake angle. By assuring accurate grinding, the new fixture saves replacement cost of dies and chasers that have been ruined by lack of the right kind of grinding



In 1944 enough grain mash will ooze through cooling pipes like these to produce a record breaking 640,000,000 gallons of alcohol, every drop of which will go toward making vital war products

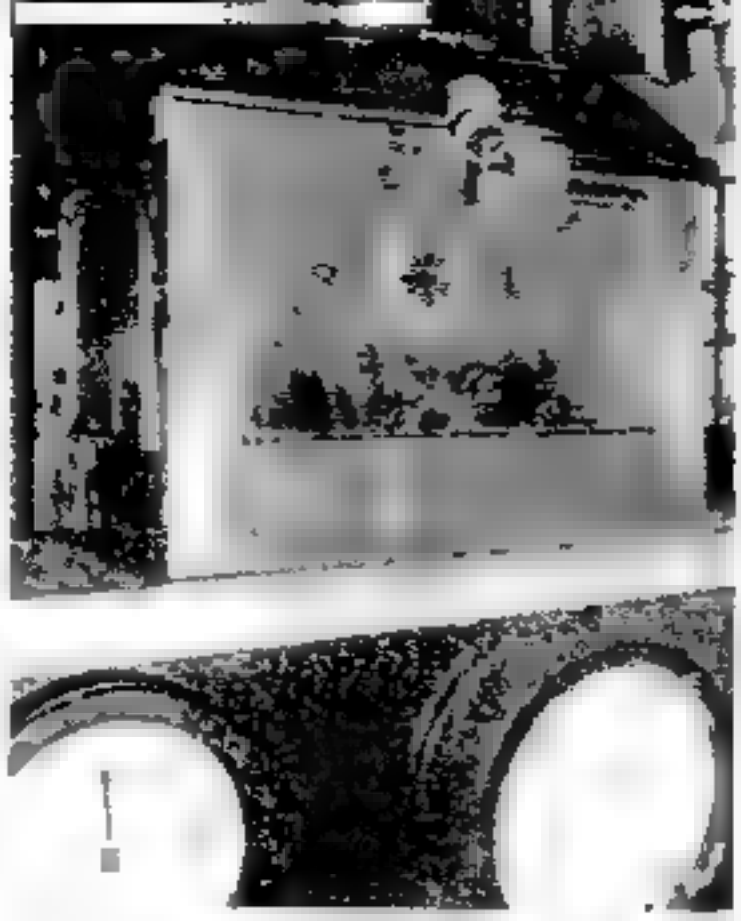
How Alcohol Handles a Thousand War Jobs

New production methods keep pace with growing demands as American distilleries pour forth a torrent of 190-proof for making rubber, ammunition, and other essentials.

AMERICAN distilleries will produce 840,000,000 gallons of 190-proof alcohol this year. This is more than four times as much as was ever made before. But this sea of alcohol is not being distilled to make beverage liquor more plentiful. It will be used to manufacture rubber, ammunition, anesthetics, and scores of other necessities of war. Alcohol is being produced for new purposes, in new ways, and from new materi-

als. It has skyrocketed to top place in tonnage in the organic-chemical field to pinch-hit for other materials.

Two years ago, no alcohol was used for commercial production of synthetic rubber. Last year, 22,000,000 gallons went into rubber. This year, 330,000,000 gallons will be used. At the rate of about 2.5 pounds of Buna-S from each gallon, this alcohol will yield 825,000,000 pounds of new rubber—enough for 800,000 Flying Fortresses, or 400,000 tanks, or 72,000,000 passenger-car tires.



As the alcohol pours from the still, it passes through a glass-lined "tail box" in which hydrometers check its "proof." For industrial use, alcohol must be 190

"Alcohol has proved to be the quickest way to get rubber *now*, when we need it most," Col. Bradley Dewey, deputy director of rubber production, declared at the opening of a $56,000,000 Government-owned plant at Institute, W. Va. "Alcohol is quickest because all over the country there are stills, mostly whisky, ready to provide alcohol."

Petroleum was America's first choice as a raw material from which to obtain butadiene and styrene for Buna-S. Technically, alcohol could serve as well, but industrial-alcohol production facilities were grossly inadequate. Then, too, nearly all industrial alcohol was being made from blackstrap molasses, brought from Cuba or Puerto Rico by tankers, and German submarines were torpedoing our ships.

Studies showed that it would be cheaper to produce rubber from petroleum than from alcohol. Time and such critical materials as steel and copper were needed, however, to convert the cracking plants. Moreover, Uncle Sam had to have 100-octane gasoline as well as rubber. So alcohol was rushed to the rescue.

The whisky distillers agreed unanimously to devote their 125 plants, representing a $100,000,000 investment, to the production of war alcohol, 24 hours a day, seven days a week. Some of these plants were not equipped to produce the 190-proof alcohol needed for military purposes, but were adapted to this work by packing their fractionating columns with rings of ceramic tile, which help to condense and turn back excess water.

Theoretically, almost any grain or sugar could be substituted for blackstrap molasses. Corn was chosen first, but big wheat crops, combined with an increase in the demand for corn as feed, soon caused a swing to whole-wheat grain.

Millions of pounds of synthetic rubber are being made from petroleum, but Colonel Dewey has "thanked God" for the plants that are using alcohol. Day and night now, in Pittsburgh, Louisville, and Institute, butadiene is being made from alcohol, and more plants for this purpose are nearing completion The lion's share of the unprecedented output of American distilleries is going into rubber. But this is only one of alcohol's many roles in this war.

At least 115,000,000 gallons of alcohol, which is more than this country produced in 1937, will be put to direct military use this year. Smokeless powder made with the help of this alcohol will hurl United Nations shells.

The first step in making smokeless powder is the production of nitrocellulose by treating cotton linters with a mixture of nitric and sulphuric acid. The pulpy mass of nitrocotton is then washed with water to remove the excess acids. The next step is to remove the water. Even after being wrung out, the cotton retains about 30 percent of the water. It has to be removed—but definitely not by heat

So alcohol is used. Water-free, or anhydrous, alcohol loves water. When forced through the nitrocellulose it carries all water out with it. A hydraulic press then squeezes the nitrocellulose into a compact block now containing only a residue of alcohol. This block is broken up, worked into a gelatinous mass by adding ether and alcohol, and then pressed into the form of a block again. Moist and slightly plastic, this new block is run through dies from which it emerges as spaghetti-like tubes. These are cut into short lengths and carefully dried. As much of the solvent as possible is recovered after each squeezing and drying.

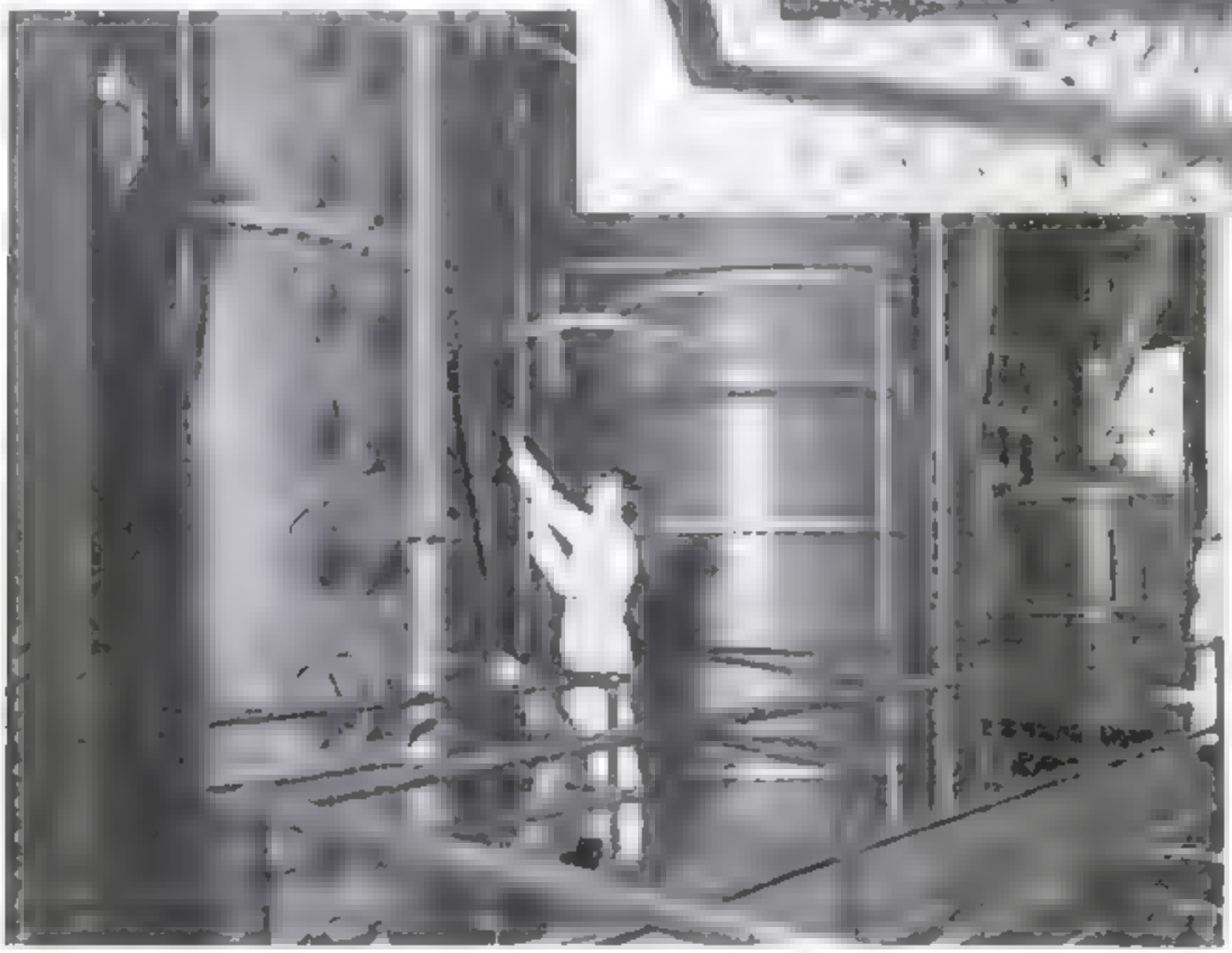
To produce 100 tons of smokeless powder, 80 tons of alcohol and ether are required. The ether, too, is made from alcohol. About 50 tons of the alcohol-ether mixture can be recovered by careful processing and used to make more powder. A single gallon of alcohol may serve to produce enough powder to fire two shots from a 155-mm. howitzer, or four rounds from a three-inch antiaircraft gun, or to keep an infantryman supplied

Because of bumper crops, wheat is being used almost exclusively in the manufacture of war alcohol. Here is an unusual bird's-eye view of the inside of a grain elevator where a mixture of wheat and corn has been stored for distillation

A batch of yeast (below) waits to be transferred to the fermenting tank where it will change the sugar, converted from the wheat's starch, to alcohol. In beverage alcohol, it is the yeast that produces the flavor and bouquet

Photographs from Schenley Distillers Corp

Below are the tall tanks where the fermented mash, containing about nine percent alcohol, is distilled up to 95 percent. Two years ago, not a gallon of ethyl alcohol was used in the production of synthetic rubber. Today 25 U. S. distilleries are producing an almost incredible 330 000 000 gallons a year just for this purpose



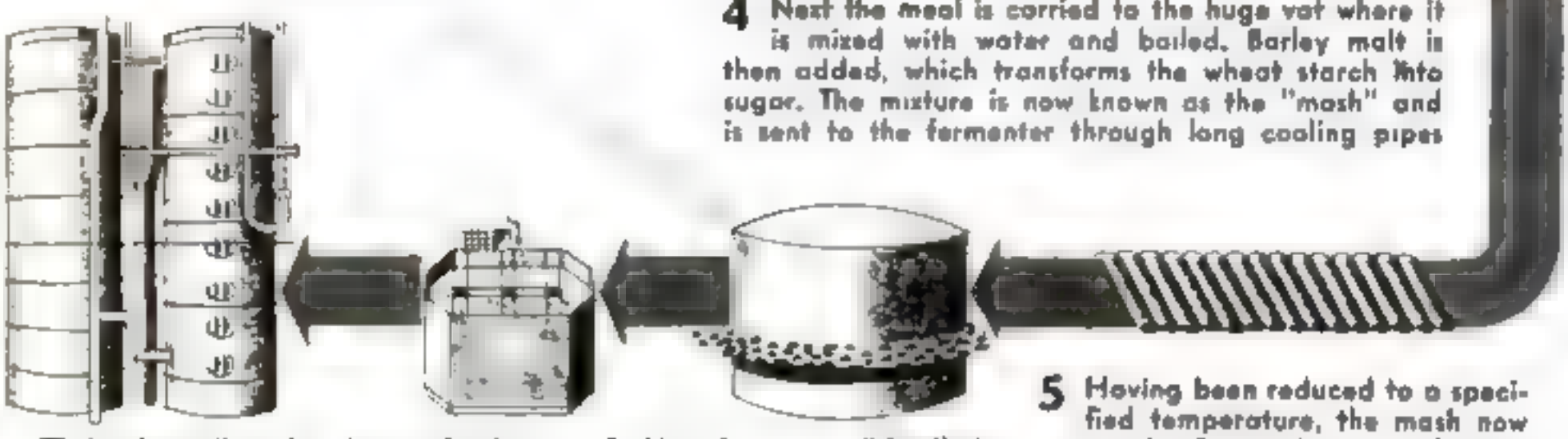
HOW ALCOHOL IS MADE

1 Before the war, industrial alcohol was made from blackstrap molasses imported from the West Indies. Now the raw material is home-grown wheat

2 After being carefully tested for quality and thoroughly cleaned, the raw wheat is stored in big concrete elevators until it is ready for use

3 Before the wheat goes to the fermenting vat, it is ground to specified fineness. If it is to be used to make rubber, it will produce 2.5 pounds for each gallon distilled

4 Next the meal is carried to the huge vat where it is mixed with water and boiled. Barley malt is then added, which transforms the wheat starch into sugar. The mixture is now known as the "mash" and is sent to the fermenter through long cooling pipes



7 In the tall tanks above, the beer is distilled up to 190 proof. For drinking purposes, its proof is reduced and it is mellowed in charred barrels, which also give it its color

6 Now known as "distiller's beer," the mash pours into the "beer well," where it is permitted to accumulate for continuous distillation

5 Having been reduced to a specified temperature, the mash now enters the fermenting vat where it is carefully mixed with selected yeast it is the yeast that turns the mash's sugar into alcohol. Fermentation takes two or three days

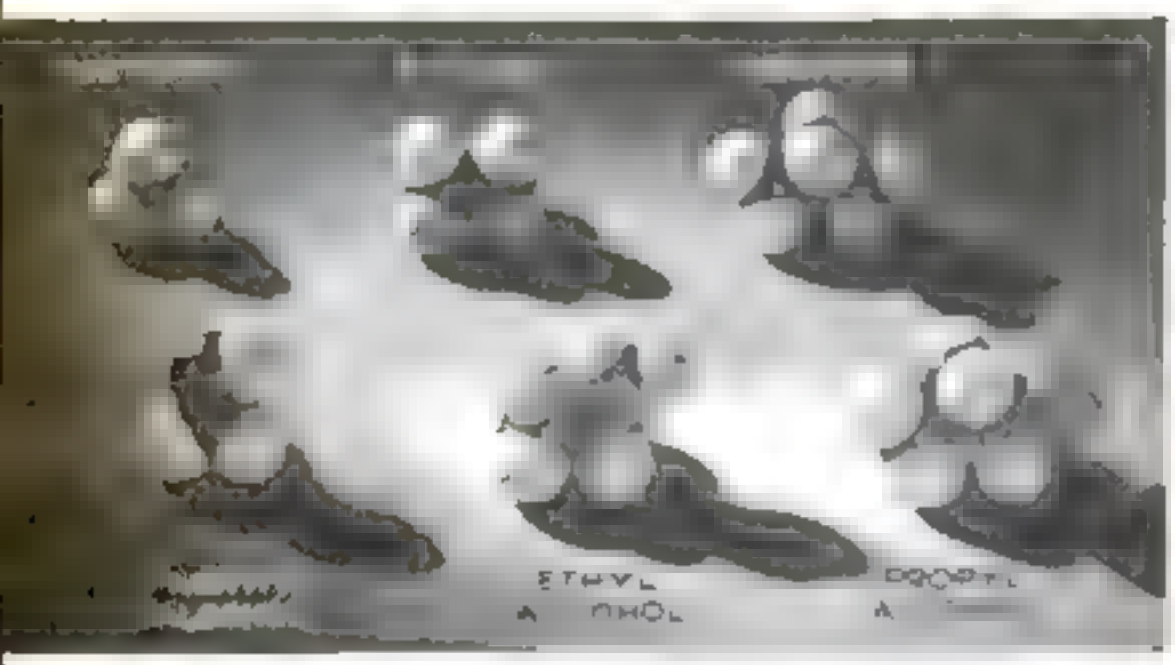
Chart Redrawn from Original by Schenley Distillers Corp

with sufficient ammunition for one month

Alcohol also gives fulminates their "wham." These are the touchy high explosives in the detonators that set off the less sensitive main charges in shells, bombs, and torpedoes. The commonest fulminate is made by dissolving mercury in nitric acid and adding alcohol. A reaction occurs that separates mercury fulminate out in flakes.

In addition to these services, alcohol figures in the production of both deadly and anesthetic gases—and gas masks.

THE CHEMISTRY OF ALCOHOL—AND TWO SIMPLE



These little clusters depict the chemistry of converting a hydrocarbon into an alcohol. In each of the three examples above, the same thing has happened: from the original substance, composed of hydrogen atoms (white) and carbon atoms (black), a hydrogen atom has been removed and then replaced with an oxygen-hydrogen combination, known as a "radical"

A test of ethyl is to take a few drops and add 10cc of iodine in potassium iodide and a little sodium hydroxide solution until brown color vanishes. Warm gently. Solution will become turbid, and iodoform crystals will form

"Mustard gas" is made by bubbling ethylene gas—which is made from either "cracked" petroleum or alcohol—through sulphur chloride. Common ether, great quantities of which are used both as an anesthetic and as a solvent, is produced by heating alcohol mixed with concentrated sulphuric acid. Chloroform is made by distilling alcohol with calcium hypochlorite, or "bleaching powder."

Ethyl-cellulose plastics, made by the Hercules Powder Company from alcohol, salt, and cotton linters, are among the new rubberlike materials used for such purposes as electrical tape, hospital sheeting, gun covers, raincoats, gloves, and footwear. This "ethyl rubber" is resistant to war gases and can be used for gas masks.

Alcohol, in fact, is as common in industry as in night clubs. As a solvent, it is second only to water. It turns up in paints, lacquers, dopes, varnishes, inks, dyes, medicines, adhesives, flavorings, and soaps. It figures in the making of celluloid and photographic film. It keeps auto radiators from freezing and de-ices airplane carburetors and propellers. It takes "knock" out of gasoline, serves as a fluid thinner in hydraulic brakes, and fills fluid indicating devices and compasses.

There are hundreds of kinds of alcohol, and thousands could be produced. Industrial alcohol is ethyl alcohol, which chemists call ethanol. It is also known as grain alcohol and spirits of wine. Among its many relatives are methanol (wood alcohol), ethylene glycol (Prestone), and glycerol, which is ordinary glycerine. The suffix "ol" brands these substances as alcohols.

Alcohols are a special group of hydrocarbons in which an atom of hydrogen has been knocked off *(Continued on page 222)*

TESTS TO TRY AT HOME

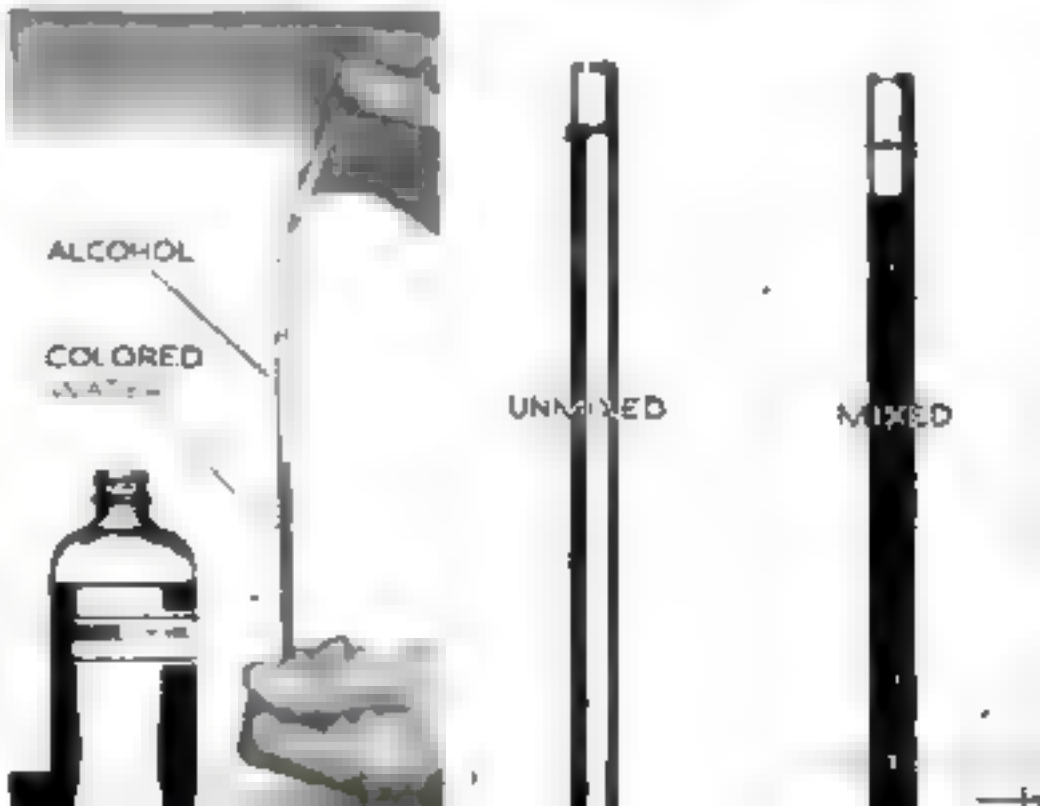
To test if ethyl alcohol contains "wood" alcohol, mash an aspirin tablet in few drops of water, add small amount of ethyl alcohol, stir in equal amount of sulphuric acid. Let stand then take a whiff. If methyl is present, you ll smell oil of wintergreen

WHAT DOES "PROOF" MEAN?

In the old days "proof" was measured by putting a few drops of an alcoholic mixture on gunpowder and then lighting it. If it burned without igniting the powder, it was "underproof." If, however, it contained 50 percent or more alcohol and lit the powder, it was considered "proof," or 100-proof

"PROOF" denotes the alcoholic strength of a mixture, and is expressed by a figure that is exactly twice the mixture's alcoholic percentage by volume. The average whisky, for instance, which is usually either 43 or 50 percent alcohol, is said to be 86 or 100-proof. "Absolute," or 100-percent pure, alcohol is described as 200-proof. This method of rating alcoholic strength is a hangover from the old alcohol-gunpowder method of measuring proof (see above). Today, in the U. S., an alcohol-water mixture of 100 volumes is rated as 100-proof when it is made up of 50 parts, by volume, of alcohol and 53.71 parts, by volume, of water. The mystery of those extra 3.71 parts is explained by the shrinkage in volume that takes place when alcohol and water are mixed (see below). For industrial use, alcohol must be 190-proof, which is the highest concentration that can be distilled

An easy way to demonstrate the shrinkage in volume that occurs when alcohol and water are mixed is to half fill a glass tube with colored water and then fill the remaining part—to a point near the top marked with a thread—with alcohol, being carefu not to mix the two. Then shake them together. You ll find that the mixture now falls short of the thread



CORN

AMARANTH

GIANT RAGWEED

WESTERN WATER HEMP

Can Hay Fever Be Prevented

Annual pollen blitz cuts production and robs the armed forces of men . . . Learn to know the guilty weeds and protect yourself from this scourge.

By JOHN GILMORE

with Illustrations by the Author

MORE than 5,000,000 chronic hay-fever sufferers, and 20,000 new ones this year, will begin to sneeze and struggle for breath about August 15. Nearly half of them will not be able to work regularly, and their misery will continue until the first frost. Hay fever has kept thousands of men out of the armed services. And it soon may impede American production as seriously as would an attack on our home front by foreign airmen with gas. But much can be done to combat this invisible menace

Hay fever does not come from hay and is not a fever. It is an inflammation of the mucous membrane of the nose, throat, sinuses, and lining of the eyes. It is caused by the pollen of hundreds of different kinds of plants. Weeds will fill the air in mid-August with a million tons of this pollen. It is so light that some of it may rise 10,000 feet. Under the microscope, some of this pollen resembles golf balls and footballs; other kinds have indentations like the fingerholes in bowling balls, and some are covered with wicked-looking spikes.

Tests have been developed to determine the kind of pollen to which an individual

SHORT RAGWEED

GIANT RAGWEED

SUNFLOWER

BERMUDA GRASS

SHORT RAGWEED

RUSSIAN THISTLE

The dustlike pollen of eight different plants that contribute to hay fever discomfort is shown by these drawings of microscopic enlargements. At the bottom of the page are four of the pollen-bearing grasses that should be avoided by sufferers

is sensitive. The skin is scratched slightly and a drop of pollen solution is rubbed in. If the solution contains the kind of pollen that affects the person being tested, a raised ridge—called a wheal—appears on his skin. He then may be given hypodermic injections of treatment extracts—called antigens—so as to develop immunity to that pollen.

Recent medical research has simplified this process. The substances causing hay fever have been found to be the same in the pollen of all members of each botanical family, and 90 percent of all hay fever has been traced to four plant families, represented by ragweed, redroot pigweed, sagebrush, and timothy. Hence, the number of tests required in many cases has been reduced from scores to four, and fewer different antigens are needed to immunize patients whose sensitivities are not unusual.

Ragweed is the worst offender. It will wreak more havoc here in the United States this summer than among the troops in the Pacific isles near the equator, tropical Asia and Africa, Alaska, and most parts of Europe. Ragweeds often have been introduced unintentionally into the British Isles and Europe, but have not flourished there. Ragweeds also are rare in China, India, and other combat zones in the Pacific. But a great ragweed belt extends from our Atlantic Coast to Kansas and the Dakotas.

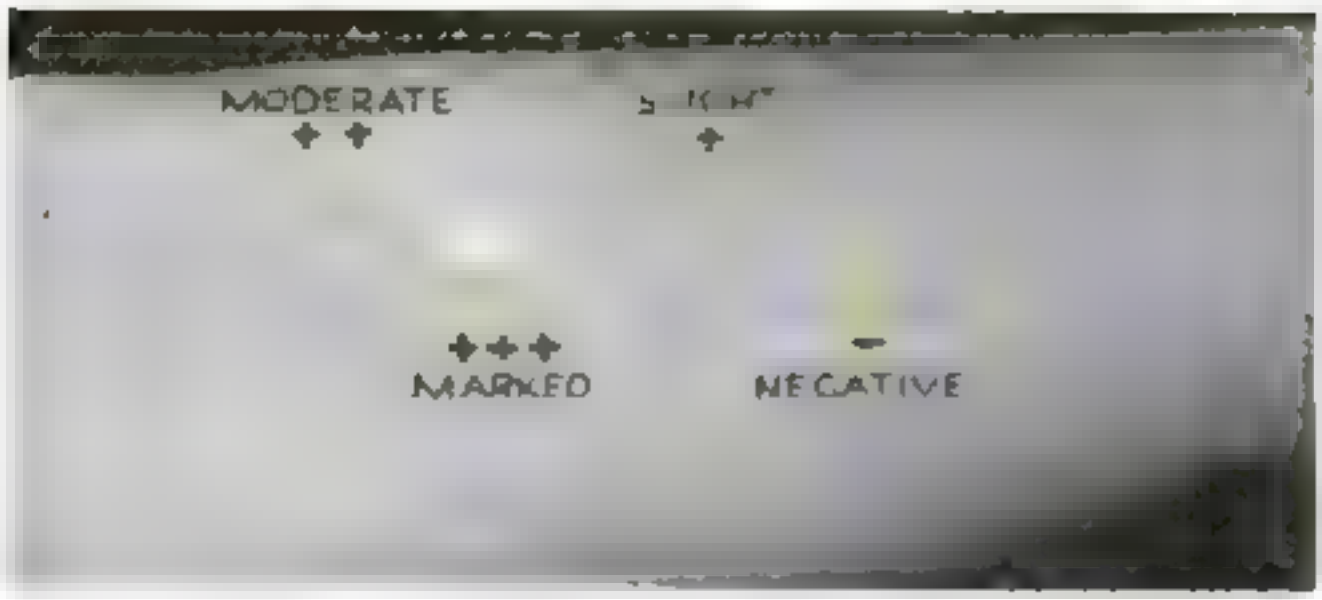
For years, experts have advocated a campaign to eradicate ragweed in the United States. But the weeds are likely to thrive this year. The manpower shortage may result in less careful tillage of fields and neglect of vacant lots. Victory gardeners may become indifferent to weeds after gathering their crops from well-fertilized plots of ground.

In the Midwest, the growing of hemp to provide the Navy with rope may add to hay-fever sufferers' woes, for its pollen will be carried for miles by the wind if it is not all harvested before it begins to shed. In the West, and in the "dust bowl" especially, the Russian thistle, a prickly tumbleweed that came over here from Russia a half century ago and is now widespread, plagues sensitive persons.

The archcriminal, ragweed, still grows unrecognized even by many of its victims. Both the giant, or horseweed, and the short or common ragweed are menaces. The former always attains a height of at least six feet and sometimes is from 12 to 14 feet high. It has thin, broad leaves, growing op-

BERMUDA GRASS

ORCHARD GRASS (COCKSFOOT)



How allergy tests reveal hay-fever sufferers' susceptibility to a given pollen. After inoculation, the size of the wheal made indicates the patient's degree of sensitivity to the pollen used. Suitable antigens are administered by doctor to combat allergy to this particular pollen

posite each other, with saw-toothed edges and deep clefts in the margins. The short ragweed is more bushy, from two to four feet high. Its leaves are feathery with an unkempt-looking appearance, and its flowers grow in spikes.

Goldenrod often has been falsely accused of causing hay fever. It blooms at the time of year when hay fever is most prevalent, but cases caused by its pollen are very rare. Nor do roses cause the early summer allergy that is called "rose fever." This has been traced to early-blooming summer grasses. Trees pollinating in April and May are also offenders at that time

Many victims have escaped heretofore to such refuges as the pine woods of New England, but now traveling is difficult. Most persons can be desensitized by from four to seven or more years of steady treatment, which may be started at any time. Temporary relief often may be obtained by taking vitamin C, wearing small filters in the nose, and avoiding drafts, cold baths, and cold drinks. Despite the high temperatures that are common in August and September, the hay-fever victim must keep warm, both inside and out. Everyone can help combat hay fever, meanwhile, by learning to recognize and destroy the offensive weeds.

TEN TIMELY TIPS ON HAY FEVER

1 Consult your doctor if you start to sneeze excessively on August 15.

2 Follow doctor's advice; don't attempt to treat hay fever yourself

3 Avoid cold baths, cooled theaters, drafts, and other sudden chills.

4 Avoid alcohol and iced drinks that lower body heat and induce sneezing.

5 Nose filters are not a cure, but may help enough so you can work.

6 Begin treatment six weeks before season; continue until desensitized.

7 Learn and avoid the plants that bear pollen to which you are sensitive.

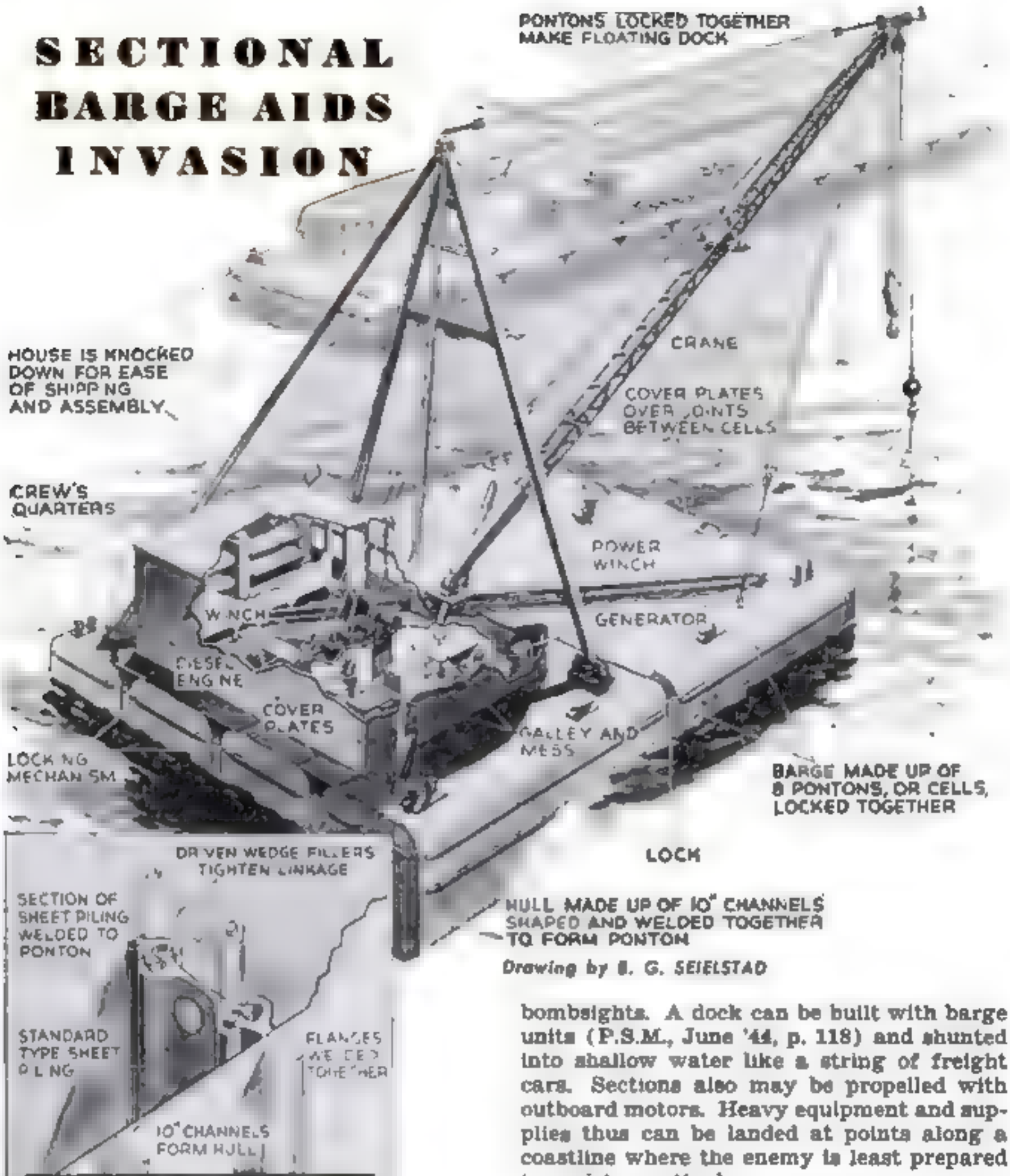
8 Clear out menacing plants from your property before they pollinate.

9 Keep your Victory garden weeded, and urge your neighbors to do the same.

10 If you do not happen to have hay fever, be patient with those who do.

Here is where hay fever hurts. This anatomical cross section shows the areas chiefly affected by the disease, which is an inflammation of the mucous membrane of the nose, throat, sinuses, and lining of the eyes. Although beginning in these areas, the victim's misery is not confined to them. Hay fever hampers our war effort seriously

SECTIONAL BARGE AIDS INVASION



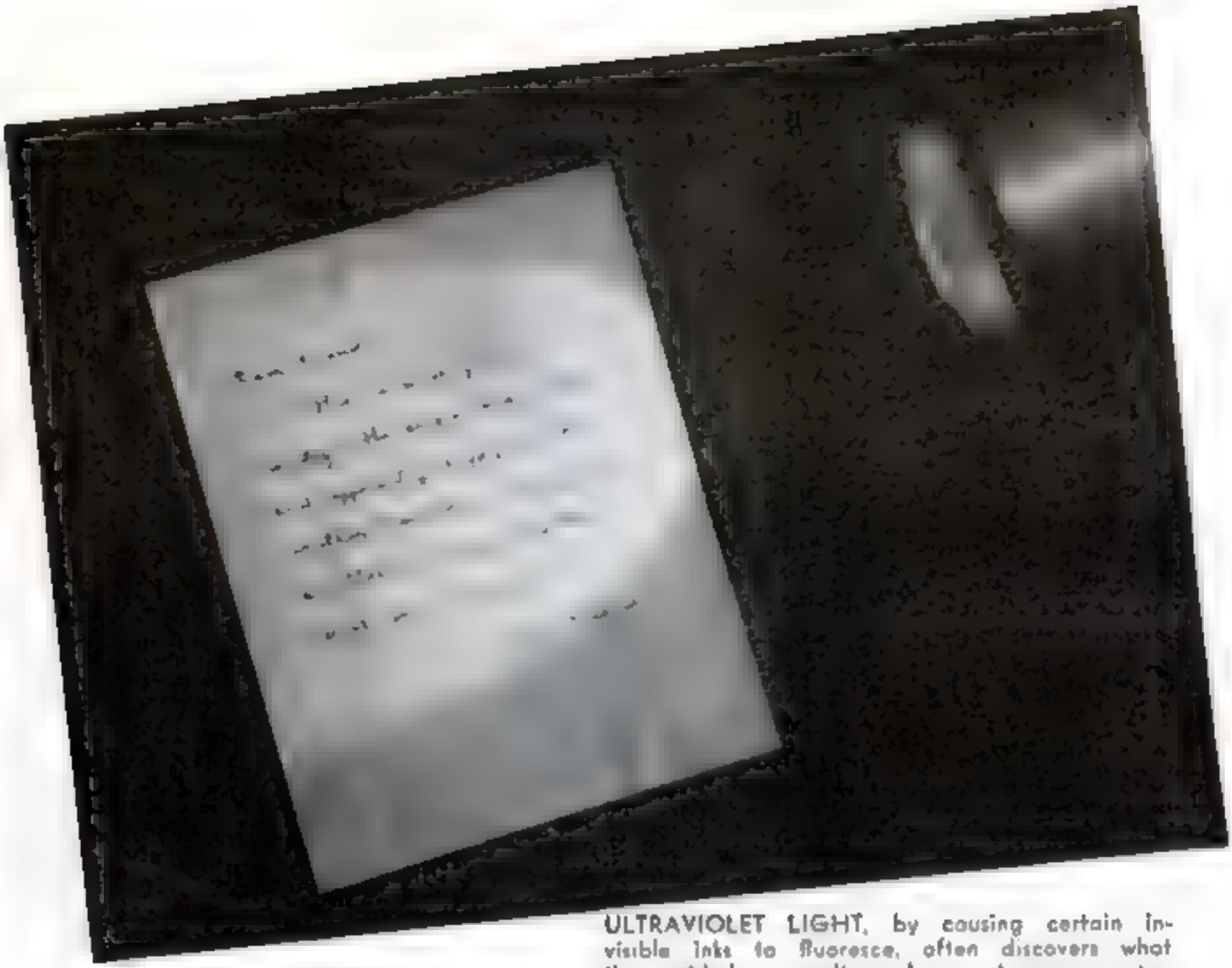
Drawing by E. G. SEIELSTAD

TO LAND supplies for American invaders on enemy shores without a harbor, our forces are equipped with floating steel boxes, eight of which can be locked together in a jiffy to form a barge for a derrick. These boxes can be hauled on freight cars or by boat, and put together in the water. No dry dock is needed, nor is any underwater work necessary, to assemble them.

Sectional barges already have been used under fire and are a development that some military authorities now consider as important, from an invasion standpoint, as bombsights. A dock can be built with barge units (P.S.M., June '44, p. 118) and shunted into shallow water like a string of freight cars. Sections also may be propelled with outboard motors. Heavy equipment and supplies thus can be landed at points along a coastline where the enemy is least prepared to resist an attack.

The sections used to support a derrick were designed by John H. Odenbach and built by the Dolomite Products Company in Rochester, N. Y. This firm also has produced slightly different types of sections for utility barges.

The A-frame derrick, like its foundation, is transported in sections. It has a 70-foot boom that will swing 30 tons within a 52-foot radius. A 135-hp. Diesel engine, in a prefabricated steel cabin, is used both for hoisting and to run the generator for electric auxiliary motors, a ballast pump, and lighting. The cabin has accommodations for a crew of four.



ULTRAVIOLET LIGHT, by causing certain invisible inks to fluoresce, often discovers what the unaided eye can't—such as a dangerous saboteur's message masquerading as a harmless letter

How Light Traps Spies and Saboteurs

With new instruments and methods, G-man scientists harness the whole radiant-energy spectrum to expose clever crooks and enemy agents.

Photographs by ROBERT F. SMITH
and Federal Bureau of Investigation

FEDERAL Bureau of Investigation agents boarded a train at Ogden, Utah, and found a fugitive from a Georgia chain gang traveling in a drawing room. He had two sets of burglar's tools, 13 sticks of dynamite, and plenty of money. There were no visible marks on the well-worn leather moneybag he carried, but it was sent to the FBI laboratory in Washington and photographed in infrared light. The obliterated words, "Deposit with the La Grange Banking and Trust Co.," were clearly legible in that light, and the bag was identified as part of the loot from a robbery in La Grange, Ga.

Such work before the war not only enabled the FBI to foil criminals, but also familiarized American law-enforcement officers with invisible light. It is now one of Uncle Sam's most effective weapons against espionage and sabotage.

When Ernst F. Lehmitz, for instance, tried to send letters abroad about his home, his victory garden, and his dog's distemper, invisible light disclosed that on the backs of those apparently harmless letters he also had inscribed, in invisible ink, highly confidential information about ships in New York Harbor. The letters came to the at-

THE SPECTROGRAPH is the latest weapon in the arsenal of scientific criminal investigation. Here a technician has placed a tiny sample of a substance in the electric arc of the spectrograph. As the sample burns, its light will be imprinted in spectrum lines on a photographic plate, which will not only reveal the sample's atomic composition but will also afford a record for possible use as evidence in court

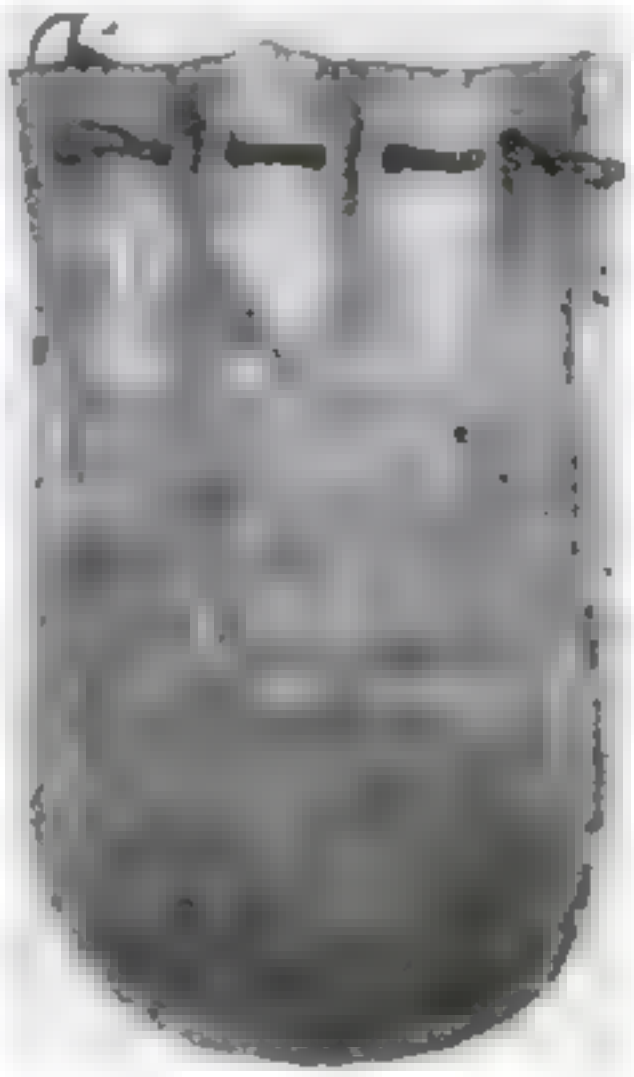
tention of the FBI and Lehmitz was sent to jail for 30 years. Thus Hitler's submarine commanders were deprived of tips that might have enabled them to torpedo countless ships.

Charles E. Wilson of the War Production Board once likened the FBI's success in frustrating spies and saboteurs to the victory over Rommel in Africa. Our enemies' efforts to disrupt American production and sever supply lines have failed, partly because of the FBI's vigilance with invisible light.

When started a dozen years ago this fall, the FBI laboratory consisted of one technician with a few instruments. It now is the world's finest crime-detection laboratory, equipped with apparatus valued at more than $1,000,000, and employing more than 225 scientists. Every day, this laboratory studies hundreds of bits of evidence: the total in the last year for which figures are available was 247,886.

Light, both visible and invisible, has become the scientific sleuths' principal tool because of the speed and accuracy with which it enables them to analyze and identify extremely minute bits of evidence. X rays and ultraviolet rays (whose wave lengths are too short for human eyes) and infrared and radio rays (whose wave lengths are too long) are being employed constantly to penetrate wartime mysteries. In fact, the whole known radiant-energy spectrum, except cosmic rays, has been put to work by the FBI — and cosmic rays will be used, too, as soon as someone finds a way to employ them.

X rays disclosed the detonators and incendiary mechanisms in the pen-and-pencil sets and blocks of wood carried by the men landed on the Atlantic Coast from a German submarine X rays also shot through a package received by a high Government official.



INFRARED LIGHT has put many a crook behind bars. In one case, a moneybag found in the possession of a suspected bank robber offered no clue until, photographed under infrared light by the FBI, it revealed the words "Deposit with the La Grange Banking & Trust Co."

1 A young boy riding a bicycle has been killed by a hit-and-run driver. Puzzled local police have asked for aid from the FBI crime-detection laboratory. The only clues are bits of car paint (shown on cotton) from which federal experts are asked to determine the make and model of the car

2 Evidence often comes to the lab in pillboxes (see photo No. 1), which are marked "K" and numbered, if the material is known, or "Q," and numbered, if the material is questionable or unknown. The technician assigned to this case begins by making a preliminary study with a microscope

5 A single speck of the paint is now prepared for microscopic examination of each of its layers. Firmly mounted in a small plastic holder, the speck is shown here being smoothed down on a piece of emery paper. By using various methods of examining the same evidence, findings can be verified

6 Here are two samples ready for the comparison microscope—one of a known material, the other of a questioned material. (Note "Q" and "K" boxes in photo No. 5.) At the FBI laboratory, scientific analyses of this type are conducted by some 225 experts who work with apparatus valued at $1 000,000

in which he feared there was a bomb, and revealed that there was nothing in it but a gavel, sent to him as a gift by one of his admirers.

Ultraviolet rays, by causing certain substances to fluoresce, have exposed telltale stains and adulterants that have been clues to many mysteries. Infrared rays, by making writing and printing that has been erased or blotted out perceptible again, have uncovered false bookkeeping entries, and alterations in the numbers on bonds. And radio rays not only have provided the quick communication essential to the frustration of subversive agents but also have been used to establish invisible fields around given areas and to sound alarms.

The increasing complexity of industry has heightened the need for shafts of invisible light. A typical wartime test of the laboratory's ability to detect more than the eye can see arose when a Cleveland motorist picked up a stranger who was waiting for a streetcar one cold, drizzly night. Both men were working in war plants and they talked about their jobs.

3 The next step is to learn if the car was finished with lacquer or synthetic enamel. By placing the car in one of these two categories, the technician can immediately reduce the number of cars that could have been involved. He therefore makes separate solutions of enamel, lacquer, and scrapings

4 Under ordinary light the solutions all appear about the same. Under ultraviolet light, however, the enamel solution shows as a bright yellow, while the lacquer solution takes on a reddish tint. By comparing the third solution with the others, the examiner can quickly tell into which class it falls

7 A card index of all the various types of paint used on standard makes and models of cars aids the examiner in identifying an unknown material. A known material, of course, needs no identification. In an investigation of this type it is likely to be a sample of paint taken from the car of a suspect

8 A photomicrograph of one of the scrapings reveals four layers, showing that the car involved received four coats of paint. As it is extremely unlikely that another car has been repainted in exactly the same way, this finding alone is strong evidence that a suspect's car is or isn't the one being sought

"Well," said the stranger, "there are some mighty funny things going on these days. Take the place where I work. If Uncle Sam ever caught on to what we're doing, we'd all be in jail."

The driver reported this tip to the FBI. It started an investigation of a plant where aluminum castings were being made for warplane engines. Laboratory research disclosed defects in some of those castings. The company and seven men were indicted. A jury convicted three of those men of violating the wartime sabotage law, but the decision was reversed by a higher court.

Another case involved damage to the fuel line of an experimental airplane. The seventh thread of a screw fitting had been cut to weaken its tensile strength. The scientists examined 176 hacksaw blades with their optical instruments and reported that only 17 of those blades could possibly have been used for that particular dirty work. Thus the detectives' list of suspects was greatly reduced.

"One of the most interesting types of cases, which has risen in importance," says

one of the technicians, "involves destruction caused by spilling or placing acids or other destructive chemicals in or on equipment being produced under the defense program. To determine the chemical employed and to observe the nature of the surface destruction often requires unlimited effort and acute and persistent observation under the microscope. But much success has been encountered along these lines and it is evident that this success is due in great part to the optical equipment."

There have been only a few sabotage trials during this war. There might have been many more, if the FBI were less scientific. Its findings have been so conclusive that some of the cleverest offenders have pleaded guilty. Frequently, too, the facts revealed by the laboratory's invisible beams of light have disproved people's suspicions. Thus, scores of persons have been protected from false charges. Scientific justice works both ways.

The gray-coated technicians in the laboratory are as impartial as their instruments. They receive the same special training as other G-men, and spend part of each year in the field familiarizing themselves with police problems, but they are primarily scientists. And in the laboratory they often have no idea whether their findings will convict or exonerate someone

The Republic Aviation Corporation's plant on Long Island was the scene of a case in which the laboratory's objectivity was pointedly demonstrated. The guns of the warplanes being built there were to be controlled hydraulically. So were the cowl, landing flaps, and landing gear. The fluid in each plane's hydraulic system, consequently, would some day be as vital to some flyer's survival as the blood in his own arteries. Yet time after time, when tests revealed something wrong with a new plane's hydraulic apparatus and the liquid was drained out, crumbs of abrasive glass were found in it.

These fragments were not like the windshield and bulletproof glass used on the planes, but were hard, heat-resisting bits of material similar to Pyrex or chemical glassware, and could cause serious damage. Suspecting sabotage, investigators searched the workers' lockers and tool boxes. In one man's kit, sure enough, they found bits of glassy stuff that looked like the fragments in the fluid.

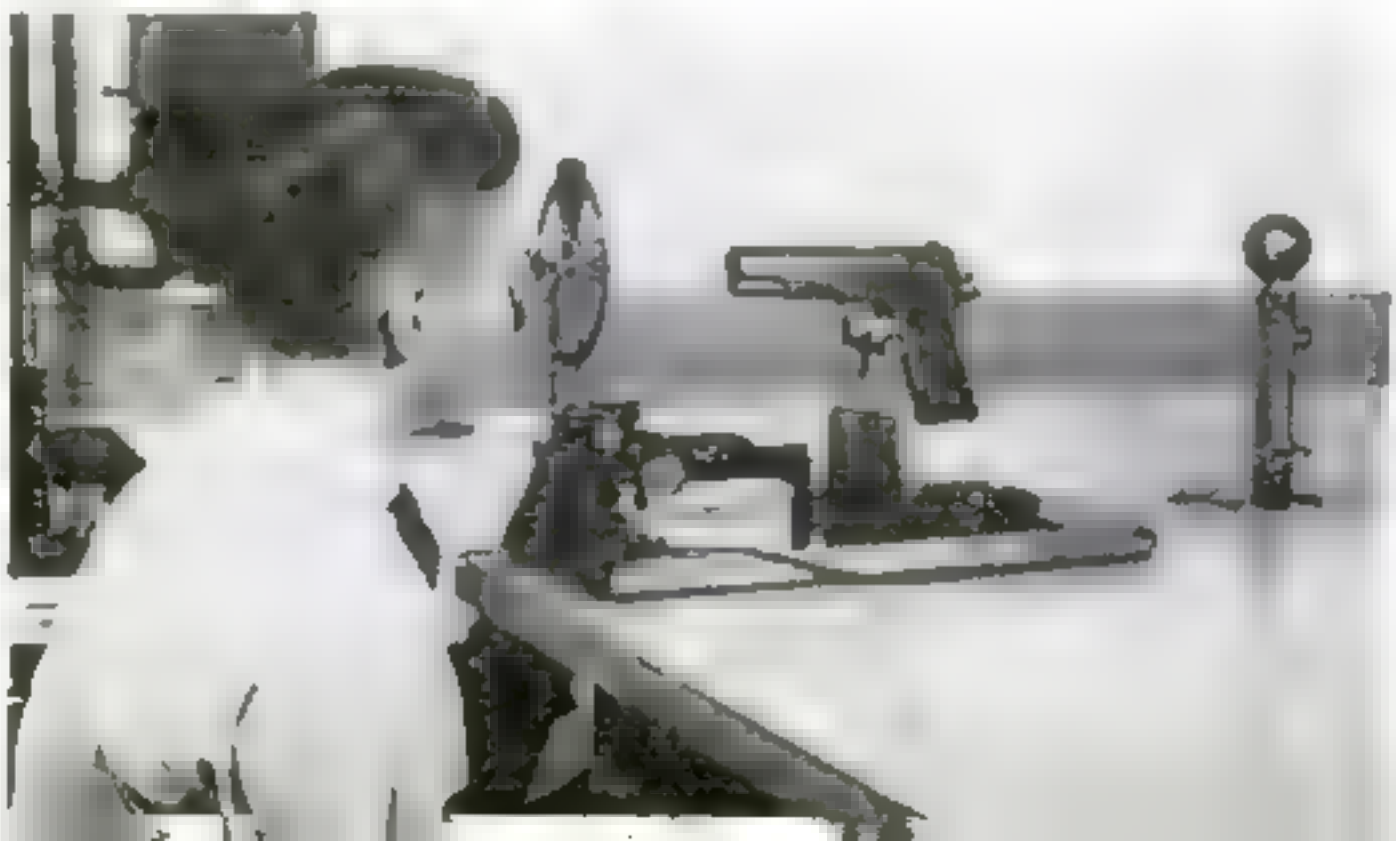
If the FBI had no better lanterns than the one Diogenes carried in his futile search for an honest man, that Republic employee would have been jailed, tried, and possibly convicted. But he was quickly exonerated by the light from burning molecules.

Specks of glass from the airplane fluid, and specks of the stuff the workman had, were wrapped in cotton, put in pillboxes and sent to the crime-detection laboratory. There a technician picked up those samples with his tweezers and placed each of them between the two carbons of a spectrograph's arc.

As each particle burned in that arc, it emitted light that passed through an angular tube extending along a desk for several feet to a photographic plate. The light of the burning speck imprinted spectrum lines on that plate, which disclosed the material's atomic composition. And those lines told the scientists, as plainly as the printing on this page tells you, that the suspected workman was not guilty. Despite outward resemblances, the ingredients of the material found in his possession were not the same as those of the glassy poison in the warplanes' arteries.

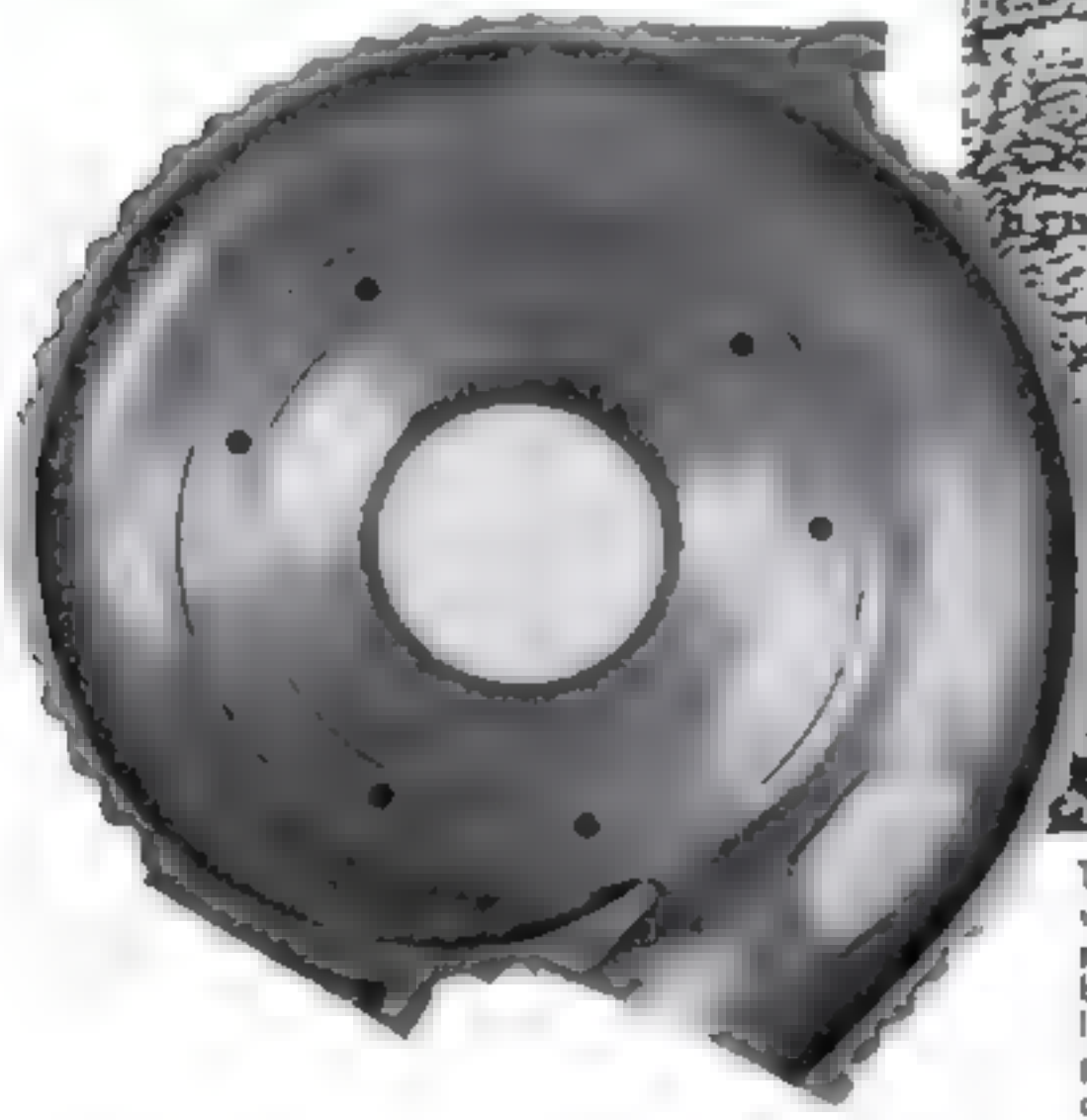
With the spectrographers' help, and the co-operation of Republic Aviation executives and employees, the FBI then discovered the true source of the crumbs in the liquid.

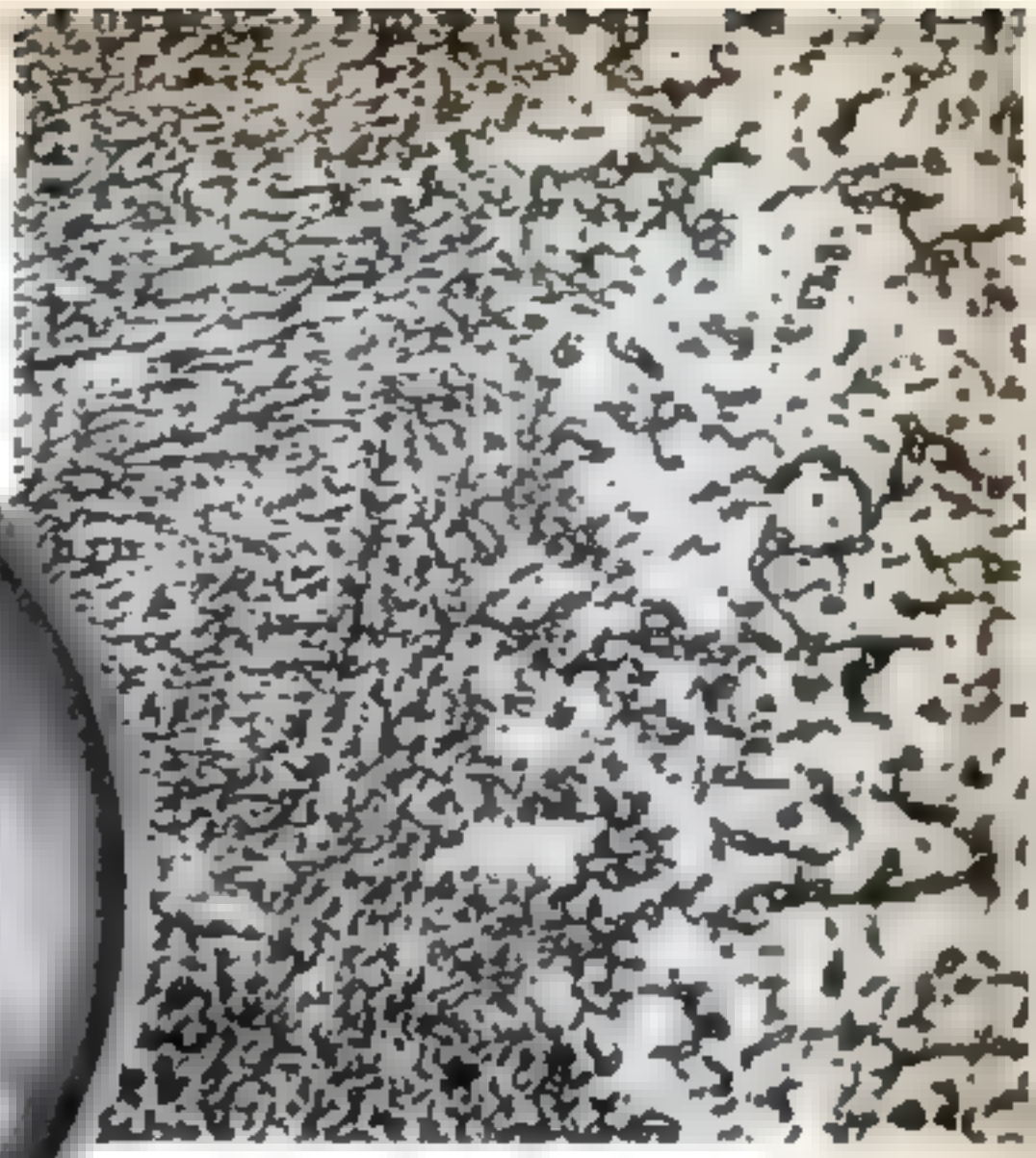
All the planes in which flakes of glass were found had been tested on the same stand. That testing stand was moved to the plant laboratory and taken apart. In its rotometer, or flow meter, for measuring the amount of fluid put into each plane, there was a glass-lined tube. That lining had cracked and part of it had crumbled



A HELIXOMETER is only another of the many precision instruments used by the FBI in its development of scientific sleuthing. Here an expert uses it to examine a pistol's rifling

X RAYS recently knifed through a dangerous piece of sabotage and put the finger on a number of patches (such as the one indicated below by light area), which had been welded on aircraft castings in direct violation of specifications. According to experts, this might have caused fatal failure of warplane engines





THIS PHOTOMICROGRAPH shows where the weld metal (darker area at left) joined the parent metal. Although there was a good bond between the two, the weld metal was below par in hardness. The welding was done to patch up the holes and cracks in supercharger castings that previously had been rejected

away. Spectrographic analysis of that lining revealed that its atomic composition was exactly the same as that of the fragments imperiling the planes. Thus the FBI both saved an innocent mechanic from prosecution and solved the aircraft-plant mystery.

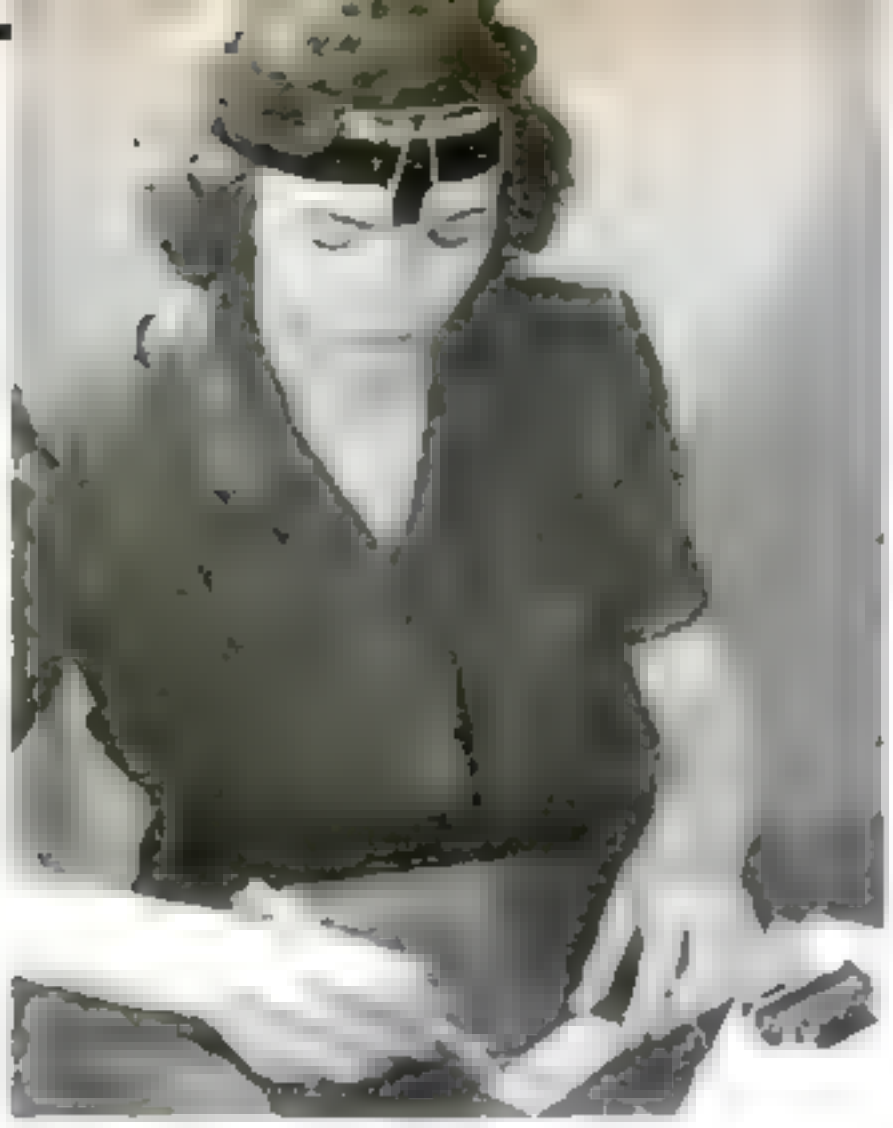
Spectrographic study of evidence is often preferable to nonoptical methods for several reasons: (1) It frequently is quicker. (2) Only a tiny bit of the available evidence need be used. (3) A photographic record of that particle can be preserved and presented in court. (4) This method of determining the ingredients of material is so accurate that elements and impurities present in extremely small quantities are readily detectable.

The spectrograph has made it possible to catch many hit-and-run drivers with mere flakes of paint as clues. By analyzing specks flicked off a car at the scene of a crash the FBI often can determine the make and model of the automobile involved, even though the car may have been repainted since leaving the factory. With similar particles of evidence, the spectrographers often can say whether a certain tool was used to jimmy a window.

This is one of the newest applications of light to police work, yet the spectrographers already are among the busiest people in the laboratory. A new spectrograph, which has an optical equivalent of 21 feet in length, is being installed this summer to facilitate more such research. With weapons like this, tested by urgent wartime challenges, the FBI hopes to be able to curb any postwar crime waves.

"The FBI laboratory has been the strong right arm of law enforcement for more than 11 years," says J. Edgar Hoover, FBI director. "It was ready to handle the many problems which arose from the emergency period and the war which followed. Its men and women technicians have uncovered some of our enemies' most cherished secrets. They have been responsible for the identification of spies, the conviction of saboteurs, and the detection of unethical persons attempting to defraud the Government.

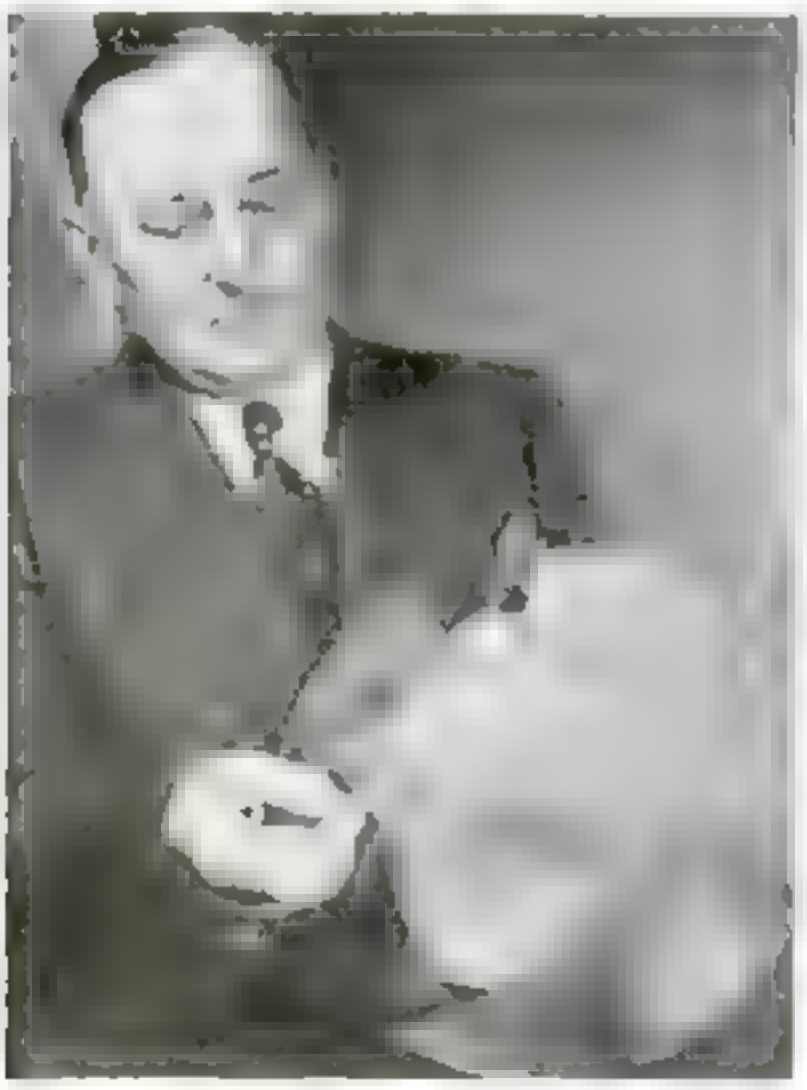
"Many who have tried to commit acts which were against the best interests of the United States have been caught and convicted because of evidence developed through the application of science to investigative problems. Our admitted enemies and the greedy chiselers who would pass off inferior war goods to our Government are well aware of the FBI laboratory's work. There can be no doubt that its record has served as a powerful force in reducing illegal practices, which are an unnecessary drain on our war effort."—VOLTA TORREY.



What's New in Modern Living

MAGNIFYING LENSES that are mounted on lightweight headbands for use by doctors, nurses, laboratory technicians, industrial inspectors, stamp collectors, and others who study fine details for long hours have recently been developed by the May Manufacturing Corporation, of New York City. They come in three focal lengths, are equipped with a vision-conversion adjustment device, and can be worn comfortably over glasses. When not in use, they can be swung up out of the line of vision. The frames, which are adjustable to eight different head sizes, are made of Lumarith plastic. Being light in weight, they can be worn continuously without causing fatigue.

ADJUSTABLE CLIPS on hangers keep clothes from being hung improperly. Sliding back and forth along the crossbar, the pins can be set to the exact width of a garment. This makes them useful for holding slacks, trousers, and skirts. Corrugations in the lower edges of the clips assure a firm grip on fabrics. These clothes hangers are made of a galvanized metal, so they are not subject to rust.



POSTWAR HATS FOR MEN may feature demountable brims with slide fasteners if the style demonstrated recently by Lynn B. Dudley becomes popular. A member of the Hat Style Council of the Merchant Tailors and Designers Association, he showed this creation at their Chicago convention.

ALUMINUM POTS AND PANS may be cleaned and polished in spite of the fact that steel wool is not now readily available. A cream polish, at present on the market, is said to clean thoroughly, to remove smudges and other discolorations in a short time, and to require only a slight amount of rubbing. The manufacturers, the Ultra Chemical Works, Inc., of Paterson, N. J., state that it contains no ingredients that are harmful to the skin. They recommend frequent applications for best results in keeping pots polished.

VINYL RESIN SOLUTION makes shoes impervious to oil, thus preventing infections. Packard employees engaged in parts-cleaning operations wear heavy wooden-soled shoes that have been dipped in this solution. Otherwise the petroleum solvents used in this work might cause dermatitis. The resin, in addition to preventing infection, protects the leather, lengthening the life of the shoes. Use of the solution, which is manufactured by the Resistoflex Corporation, of Belleville, N. J., permits assignment to parts cleaning of workers who would otherwise be harmfully affected by the solvents.

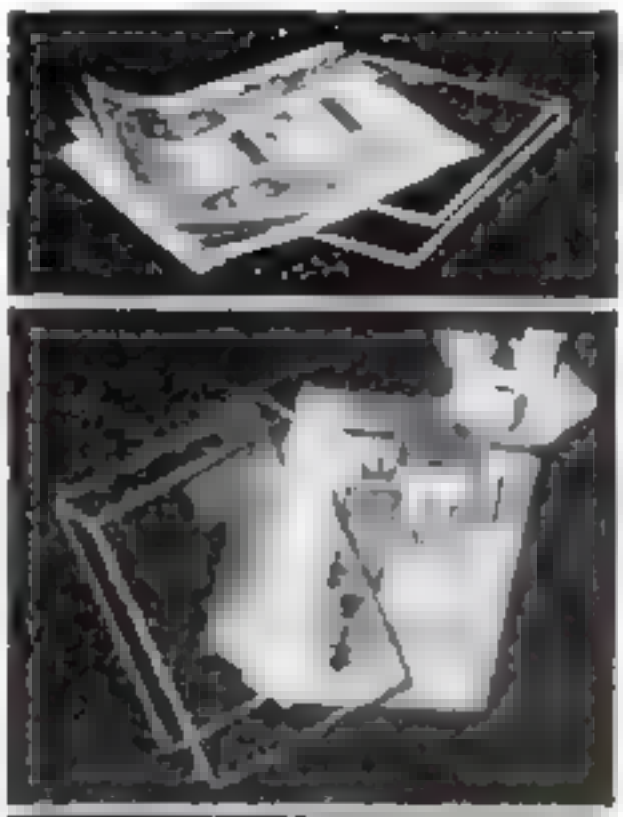
LIBRARIANS especially will be interested in the convenient and time-saving desk on wheels designed by Miss Martha Neville, of the Presbyterian Hospital, Pittsburgh, Pa. It is constructed of plywood on an oak frame and finished in oak. Miss Neville divides her time at the hospital between two far-separated libraries. With this desk she easily moves her equipment about with her.

PLEXIGLAS GIFT ITEMS are now available for the first time since the war began. The attractive accessories shown here are fashioned from the same transparent plastic that is used for observation domes, gun turrets, and bomber noses in American warplanes. As transparent as optical glass, Plexiglas is stainproof and unbreakable. It can be sawed or carved like wood and machined, drilled, and threaded like soft metal.

These items are the products of the Vargish Company, of New York City. Now that some transparent plastic has been released for civilian use, many such items will appear in the smarter stores.

Included in this group are a pack holder to prevent cigarettes from crushing and tobacco particles from sifting into your purse or pocket, a card holder to keep playing cards fresh and protected from damage, a photo frame for your favorite pin-ups, and a money holder to keep your bills together.

Each of these Plexiglas products is a one-piece design. All are strong, thin, unbreakable, light, tough, and water clear. Easily recognizable here are a bill clip, a case for cigarettes, a card holder, and a brilliant, crystal-like photo frame. Plexiglas is the plastic used so extensively for the transparent housings on American airplanes



YOUR POSTWAR AUTOMOBILE . . . AS POPULAR SCIENCE READERS SEE IT

New Features for Tomorrow's Car

READERS TELL WHAT KINDS OF BODIES, ACCESSORIES, AND GADGETS THEY THINK FUTURE MODELS SHOULD HAVE

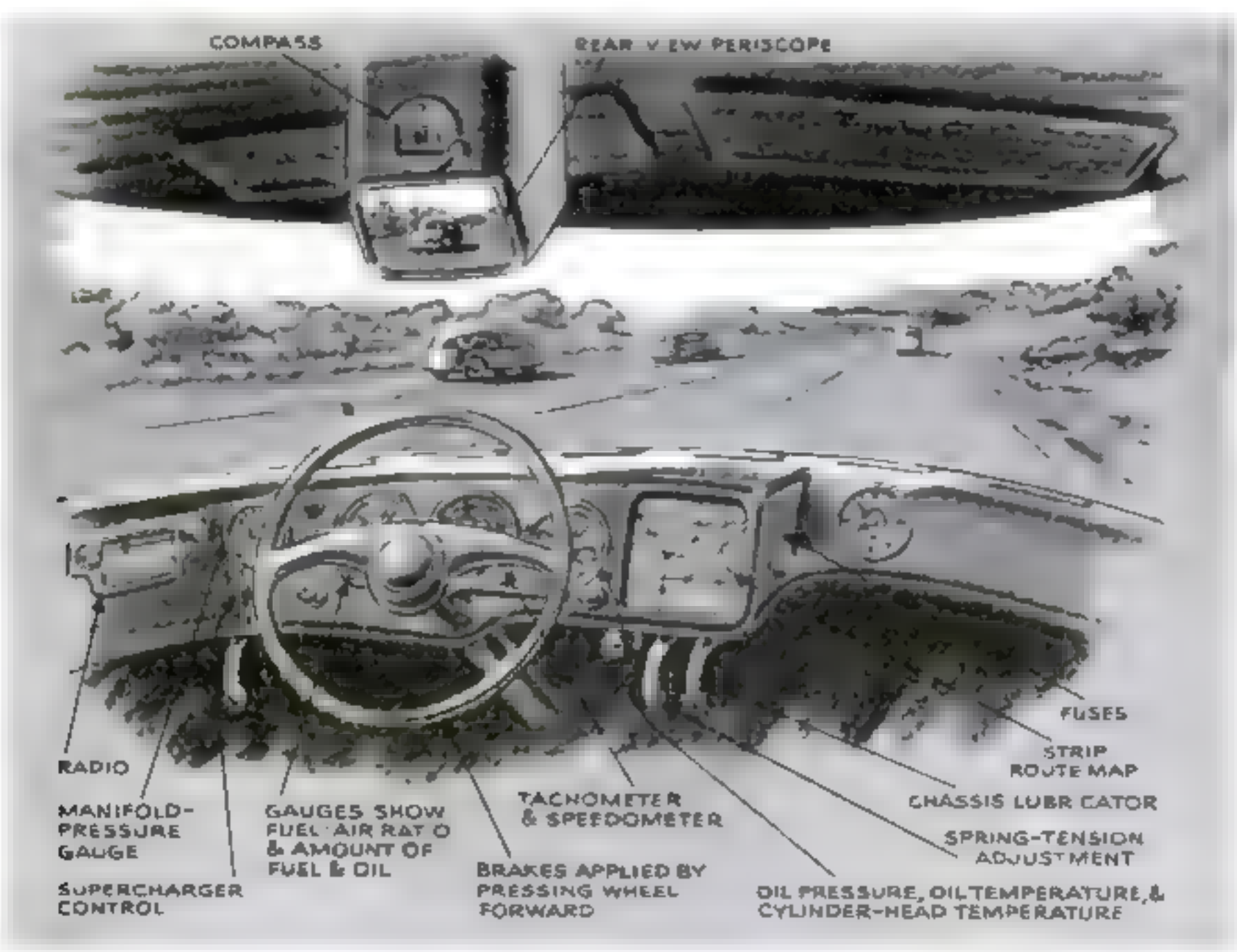
"SOMETIMES," said Gus Wilson genially, "I wonder if the Model Garage hadn't better go out of business. These superfancy postwar cars they talk about—guaranteed marvels of metallurgy and engineering, complete with plastic pistons and built-in television—will probably run 100,000 miles without servicing and use bacon drippings instead of gasoline. What does that leave for monkey-wrench mechanics like Stan here and me?"

Gus and Stan Hicks were in the POPULAR SCIENCE editorial offices for a second discussion of readers' letters on postwar cars (see P S.M., July '44, p. 126), and Stan hadn't noticed the twinkle in Gus's eyes.

"Why, Mr. Wilson," he said seriously, "just yesterday you were telling me that modern cars take more and more honest-to-gosh knowledge on the part of the mechanic. You were showing me how the automatic choke on Mr. Atkinson's coupe worked, and you said the time was past when a fellow could fix a car by guess and feel."

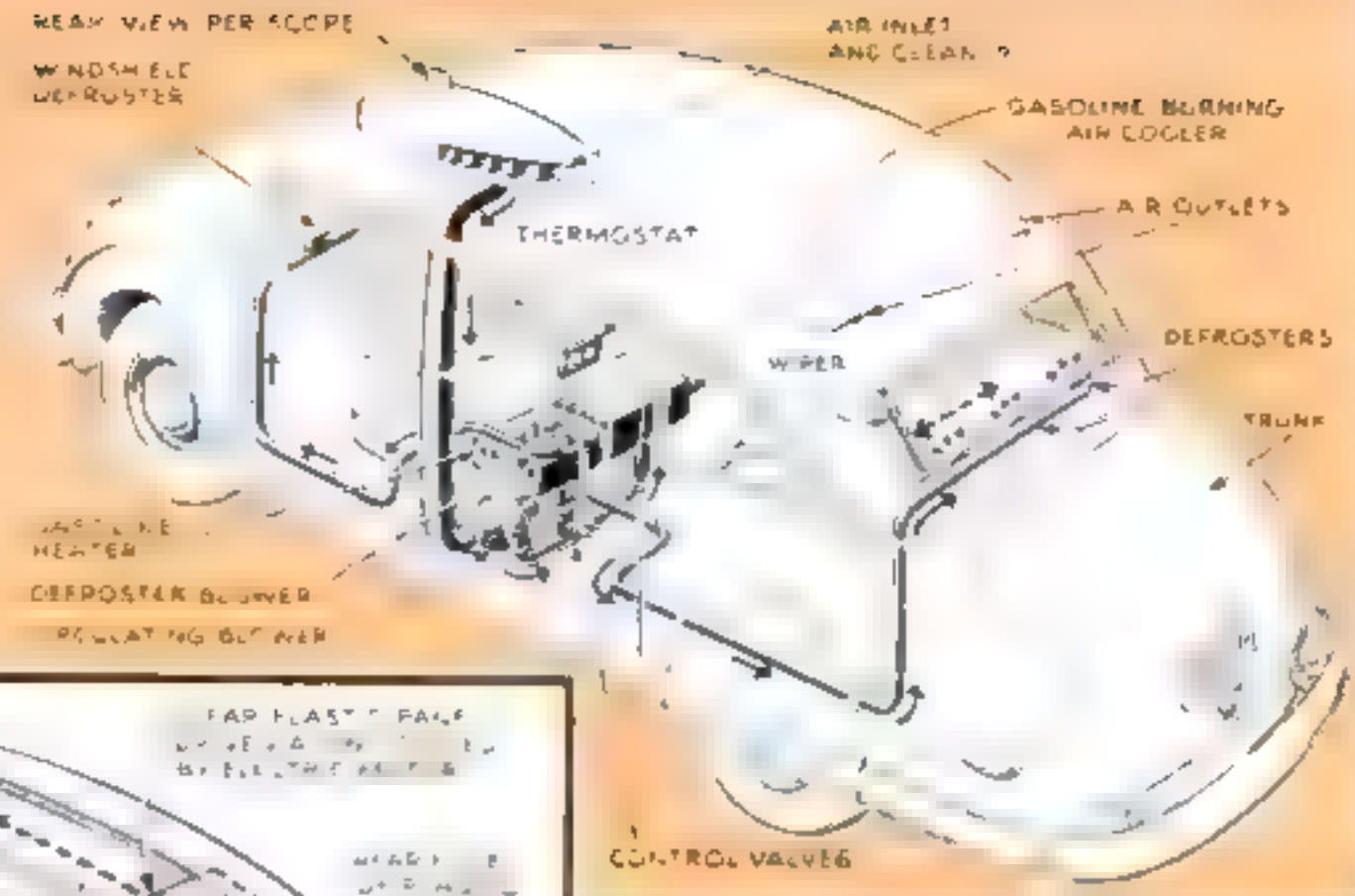
"Sure, Stan," said the Auto Editor. "I don't think you've caught Gus with his logic down. He was only gently ribbing those people who have gone overboard in thinking about cars to come. But do you mean, Gus, that many readers' letters belong in the magnesium-motor and plastic-teardrop class?"

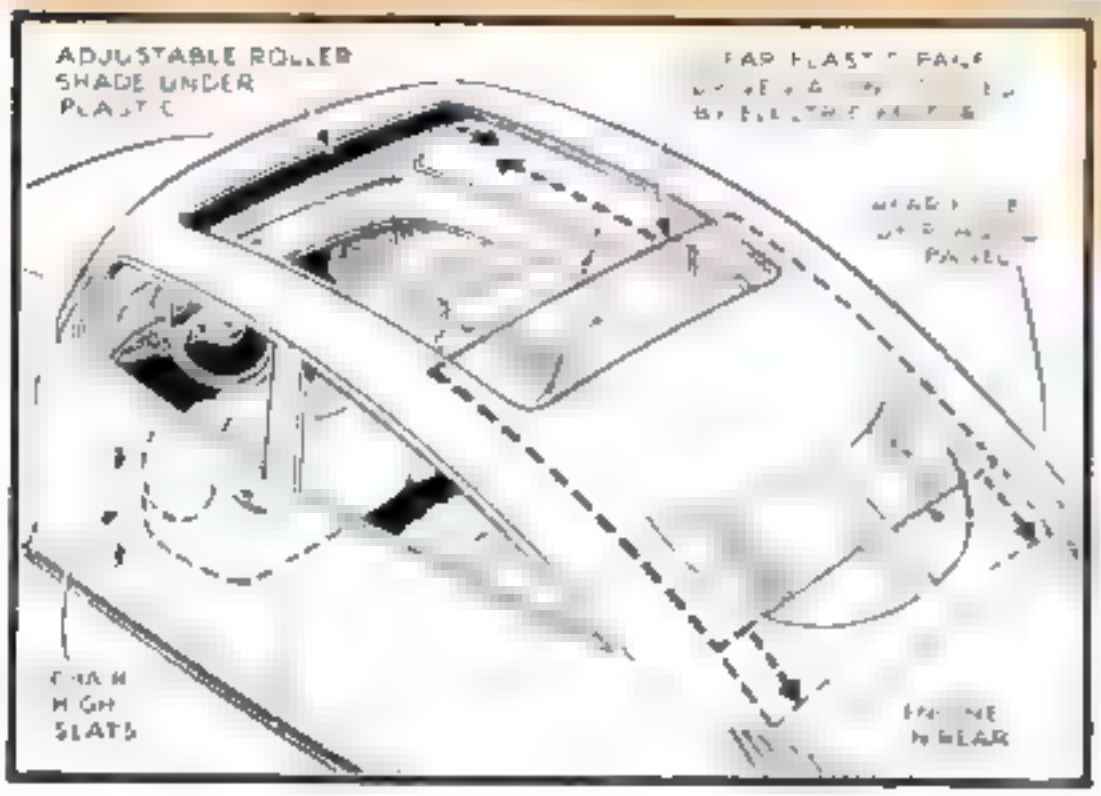
"I do not," Gus said positively. "Most readers seem a whale of a lot closer to problems of auto design than some of the stylists whose drawings you see today. They understand that there's a pile of difference between a job that looks pretty on the drawing board and a car that can take a rutted dirt road without running aground on its crankcase."



Air conditioning is a favorite of many to provide heat for winter and cool air for summer. A unit might be designed so compactly as to fit under one seat

Below, a retractable roof panel of clear plastic, sliding into a steel top. The combination might link convertible comfort with hard-top safety





Gus paused to stoke up his pipe. "Take these letters," he resumed, indicating a stack on the Auto Editor's desk. "A sizable bunch of them complain about cars that have insufficient road clearance, which, as I recall it, had run about as low as 7" in some prewar cars.

"Some readers thought the clearance problem might be licked by selling cars with the option of several different sizes of wheels and tires, thus allowing the owner to pick the clearance he needed. Of course, this brings other problems: changing wheel diameter is the same as changing gear ratios, and besides, clearances between wheel and fender or frame would have to be right for the largest wheel. Another suggestion was for manufacturers to put out special models with extra-high clearance, which I think some were already doing before the war."

"Doesn't high clearance mean that a car won't hold the road as well?" asked Stan.

"Not entirely," the Auto Editor explained. "Naturally it's desirable to keep the center of gravity low. But roadability is affected by other factors as well."

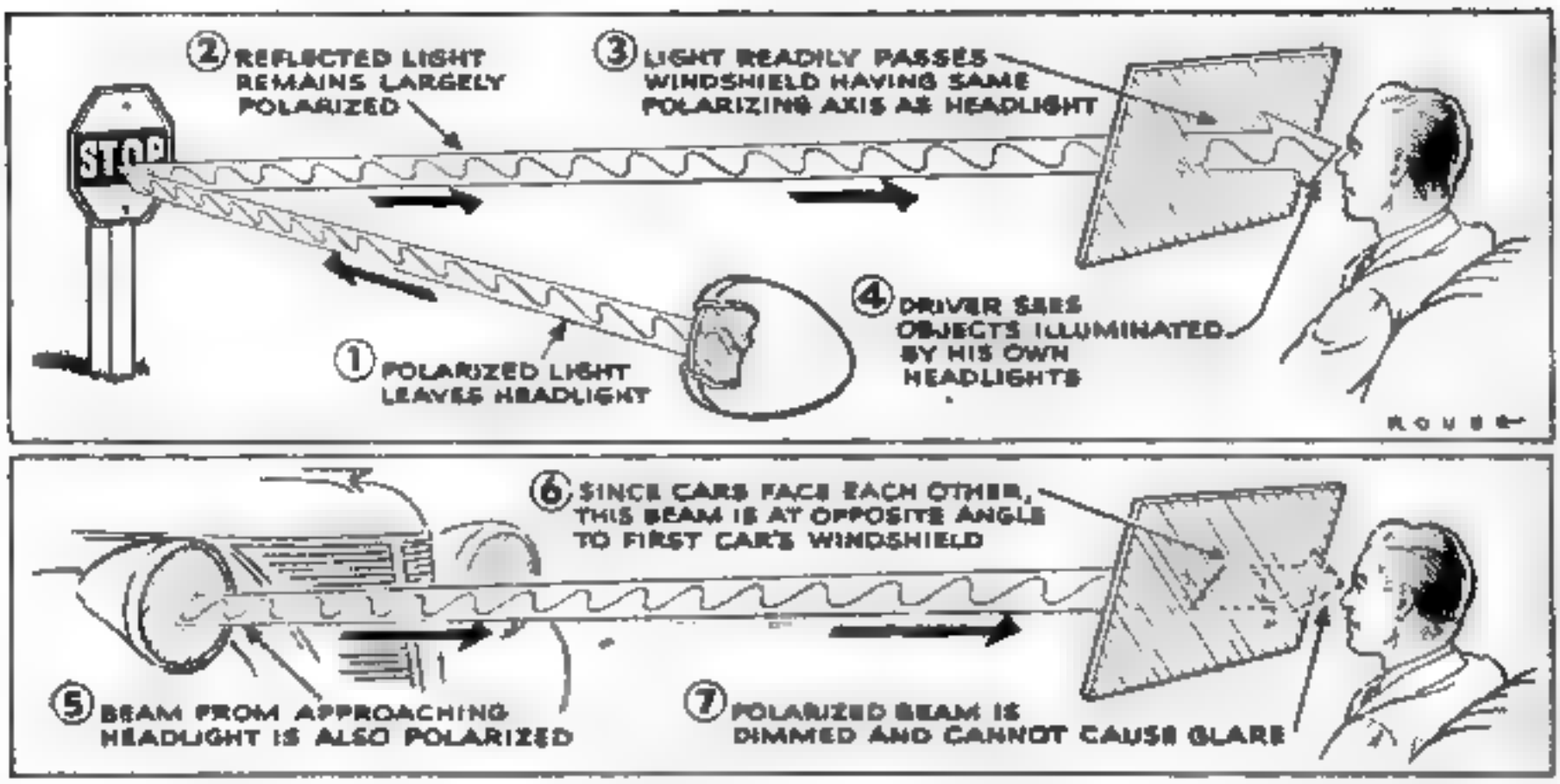
"Poor visibility for the driver was a favorite squawk," Gus continued. "Here's a typical letter, from C. H. Woodward, of San Diego, Calif.: 'I want to see the road ahead. Let's cut out some of that ballooned hood and its glaring reflections. I want a strong longitudinal and transverse framework up in front for protection in case of accident. I'd have an escape hatch in the rear, and opaque shutters to control glare from ahead or above.'

"Here's another letter, this one from Arthur W. Stevens, of Boston, Mass.: 'The auto is the most lethal peacetime machine that man has invented. Stylists have placed the driver halfway or more back in the car and have erected a great hood in front so his ability to see the road is greatly reduced. The feature most needed is driver-in-front design.' "

"It isn't impossible," the Auto Editor commented, "to give improved visibility and still keep the motor in front. There was a trend toward greater windshield and window area before they stopped making cars."

Gus selected some more letters from the stack. "There are some other interesting safety ideas here. Several readers mentioned designing the inside of a car with the chance of a smashup in mind—recessed control knobs, crash padding, and a steering wheel with a padded center and springy spokes. One or two liked the idea of a plane-type safety belt. Some thought rear-wheel steering would make cars safer on curves."

"Rear steering, you know, isn't a new idea," remarked the Auto Editor. "I think they've found that it does have some advantages at high speeds and in fast turns. The hitch comes in traffic. It wouldn't be so good there because the rear of a car swings out on a turn." [*Turn the page.*]



Glare from the headlights of approaching cars would be eliminated by a system of polarized headlights and windshield, yet each driver would be able to see perfectly along the road lighted by his own beams

"I don't get it," Stan said.

"Suppose a pedestrian suddenly popped into the street," Gus explained. "The driver yanks the steering wheel to, say, the left in order to miss him. If the car had rear steering, the front might change direction sufficiently, but the back would swing to the right—it would be just this rightward swing that caused the front to point the other way—and the pedestrian might get clipped."

Stan grinned. "Okay. So I'm a dope."

Gus resumed consideration of the letters before him. "There's another point that turned up real often—the value of a hard steel top in upsets. A lot of people wrote that they'd like a convertible that offered more protection to the driver. Several suggested that the best compromise between the pleasantness of an open car and the comparative safety of a closed car would be a sedan with a sliding roof panel."

"How about air conditioning?" asked the Auto Editor.

"It's darn popular. About the only people who voted against it were those who thought it might be too expensive or complicated, or those who wanted a rugged, jeeplike car. For instance, here's a note from T/Sgt. James A. Adams, of Tampa, Fla., who used to sell cars before the war: 'I believe I'd have no trouble in selling an air-conditioned car with windows molded into the body. It's a good selling point with the ladies—who'd usually rather roast with the windows up on a hot day than let the wind blow their hair.'

"Other readers wanted air conditioning, but without fixed windows. Gasoline-burning hot-air heaters proved popular. Several suggested that if regular air conditioning was too complicated or costly, evaporation coolers might do, or coolers using dry ice, which could be sold by gas stations."

"Where would the air-conditioning equipment be located?" asked the Auto Editor.

"It might be up front, or in the rear, or even under the front seat. One thing a lot of readers did want was plenty of storage and luggage space, easy to get at and unobstructed by spare tires. As one man pointed out, many drivers make use of luggage space in their everyday work—salesmen, electricians, plumbers, and farmers, for example—and the size and convenience of the compartment mean a lot to them."

"I've often had a hankering," remarked the Auto Editor, "for one of those sedans in which the seats fold flat to make a bed. They made cars like that before the war, of course, but I'm curious to know if many readers liked the idea."

"They sure did," Gus laughed. "Several readers suggested that after the seats were folded flat, a thin mattress rolled up at the top of the luggage compartment could be pulled out—something like a window shade."

"How about instruments and dashboard accessories?" asked the Auto Editor. "What suggestions did readers have?"

Gus tilted back his chair. "You get the feeling from reading these letters," he said slowly, "that the kind and number of instruments depend a lot on who's going to drive. For instance, the man without much mechanical knowledge, who uses his buggy to give the wife and kids a Sunday drive, would probably be satisfied with just a fuel gauge and speedometer. The fellow whose dream

car is a high-performance job, complete with supercharger, automatic transmission, and the like, wants a full set of instruments.

"Some suggestions were kind of interesting. One man wrote that he wanted indicators showing oil temperature, cylinder-head temperature, and carburetor-air temperature; and he also wanted a manifold-pressure gauge and a tachometer. A number of others said they thought flashing light signals might be preferable to gauges: one light might flash red when the engine got dangerously hot, another when the oil pressure was too low, and a third when the gasoline supply dropped to half a gallon."

"I hope those drivers will find time to look at the road," commented Stan.

"What about other accessories and gadgets?" asked the Auto Editor.

"There were a heap of them—and a lot of people often had the same idea. Here are just a few of the ones that caught my eye." Gus leafed through the letters.

"A rear-view periscope in front of the driver just over the windshield to give a clear, unobstructed view of the road behind. A master switch on the dash which would cut off everything but the starter circuit—to save time when a short circuit started the insulation burning, or when the horn wouldn't stop blowing

"A double-hinged door that would still open when a car was parked alongside a wall or another car. A small steel flask containing air under pressure for use in pumping up tires. A distilled-water container connected by a gravity feed line to the battery so the battery plates would never become uncovered.

"A system of polarized headlight lenses and windshields that would prevent all glare from oncoming cars but still let each driver see perfectly by his own lights. A dashboard gadget for adjusting body springs as well as shock absorbers in order to secure good riding and roadability with different loads and road surfaces. A built-in trailer hitch, including plug-in jacks for the trailer lights, a phone, and brakes.

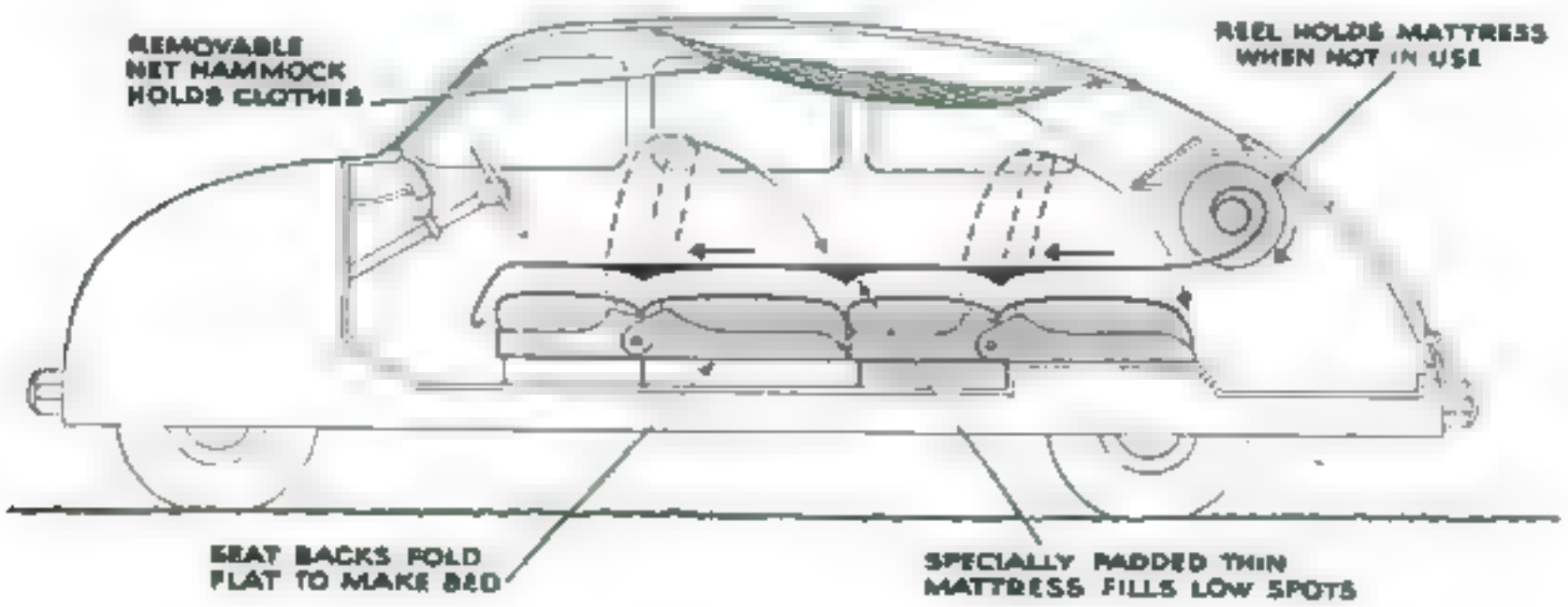
"A power capstan so a car could pull itself out of mudholes. A photoelectric headlight dimmer. A continuous-strip map for the dash. A spring-loaded reel of wire with a jack at the end for using a trouble light or an electric razor, or for bringing a light over to a picnic grill or tent. A steering wheel that, when pushed forward, would apply the brakes . . "

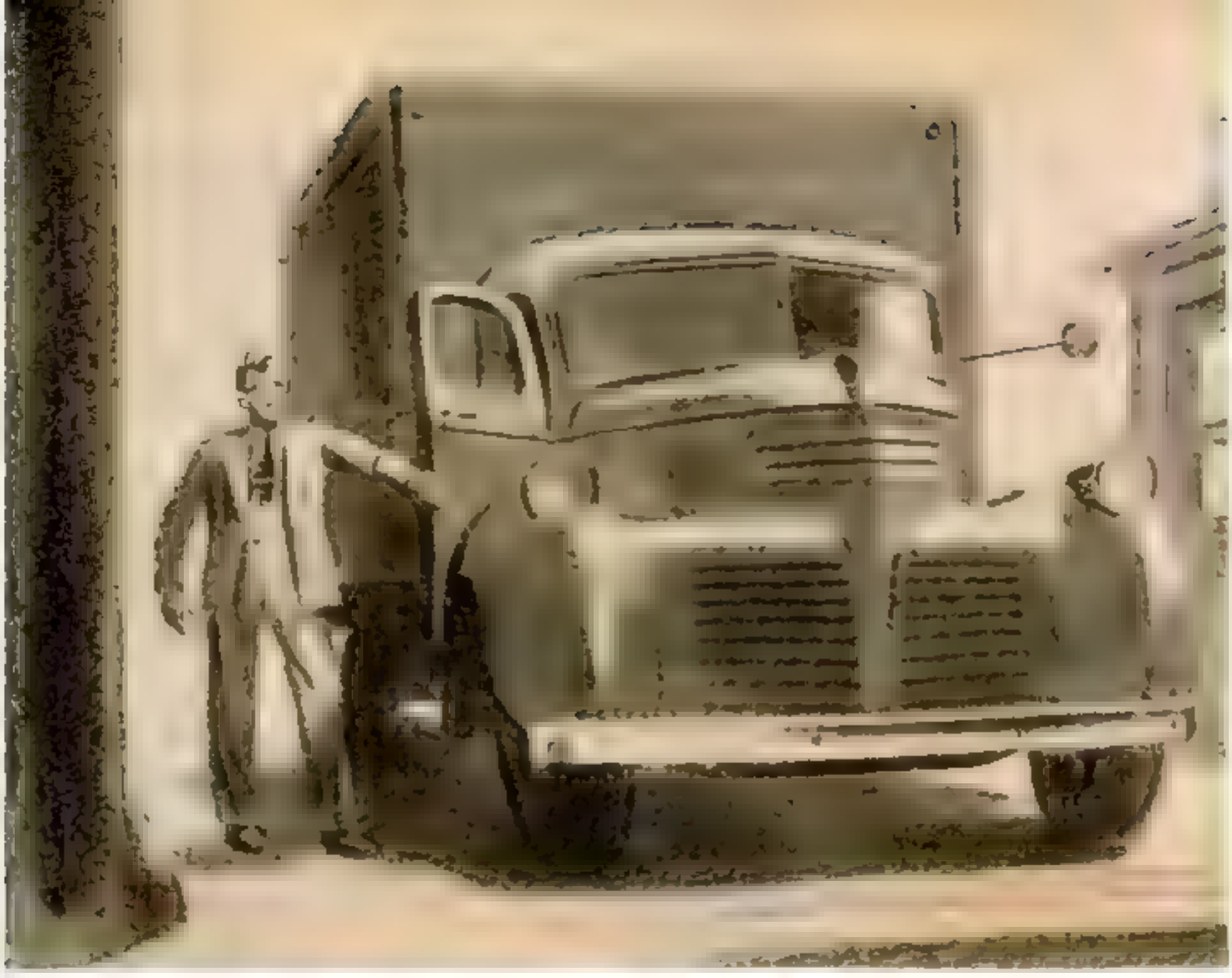
"Whoa!" hollered the Auto Editor. "What do you think of these notions, Gus?"

Gus caught his breath. He knocked out his pipe, looked at his watch, and stood up. "Stan and I promised Joe we'd be back early to spell him at the Model Garage. As far as these ideas are concerned, some of them are brand new to me, and others are kind of familiar. I suppose that whether any one of them is really sound depends on whether it can be made practical—from both an engineering and a cost basis—and also whether it meets enough need.

"But considering that individual drivers have special needs, and remembering that the engineering boys can do pretty smart things these days, I'd say that we owe P.S.M. readers a vote of thanks for contributing some really tricky notions. Maybe it won't be so long before we'll be seeing new cars with some of their ideas built in."

Here are two roadside conveniences —emergency tire inflation (above) and a built-in bed for long trips





GUS BLOWS THE OTHER

By MARTIN BUNN

IT WAS two o'clock in the afternoon of the third and most torrid day of a hot spell. Sprawled comfortably in a chair just inside the shop doorway, where he was out of the sun but in the path of any stray breeze that might stir, Gus Wilson closed his eyes. For the first time in months he had no rush jobs.

The unaccustomed quietness in the Model Garage got the better of him. His chin slumped, and his pipe slipped gently out of his mouth. He was at his favorite lake casting for bass. A large-mouth grabbed his River Runt, he worked it to the boat, and fumbled for his landing net. It wasn't there. He reached for the prize with his left hand, and it closed around something cool and wet.

Gus woke with a start. A shaggy dog, its tail swishing, was pushing its cold nose into his hand.

"Why," Gus said, "it's Dodger! Hello, old boy! Where's your boss?"

"Right here, Gus," a voice from the doorway said. A tall young man limped over, his hand extended. "Gee, it's good to see you and the old shop again!"

Gus shook hands. "I'm glad you're back, Tim," he said. "I'm sorry about your leg."

Tim Sheridan grinned. "Getting out of Italy with nothing worse than a bum knee was a break," he said, "although I'd rather have stayed for the finish. But I'm back, and you'll find me as big a nuisance as ever."

In spite of 25 years' difference in their ages, Gus and Tim are close friends. While still in knee pants, Tim spent much of his time in the Model Garage shop. Gus insists he has more than a touch of mechanical genius. Tim worships Gus as a master mechanic.

Gus assumed a wry expression. "That reminds me—someone down in the city phoned to know if I'd recommend you for maintenance super for a truck fleet. I told him I guessed you wouldn't do any more damage than anyone else."

Tim laughed. "Thanks for the unqualified endorsement. It got me the job. I'm on

FELLOW'S HORN

trial to see if I can do the work all right."

"Well," Gus said, "you can, can't you?"

Tim's face tightened. "I *thought* I could," he replied. "Now I'm not so sure—and neither is Swinton, the general manager. That's one reason I'm here."

Gus jerked a thumb at the chair he'd vacated, and pulled up a box for himself. "Take the weight off that knee," he suggested, "and tell me about it."

Tim sat down, produced tobacco and papers, and rolled a cigarette.

"This company is operating a fleet of 20 trucks," he explained. "The first week 19 were working, and I didn't have any trouble. Then No. 20 came back from the repair shop after a ring, bearing, and valve job. I road-tested it, and it ran swell. Then one night the driver reported trouble—on his way in, the engine skipped and then stopped. After a quarter of an hour, he stepped on the starter, and the engine took off and brought him in.

"I checked the gas line first. It was O.K.; so was the fuel pump. Next I went over the ignition wiring and the connections. Then I took the carburetor off and disassembled it. I noticed the float had been rubbing the side of the bowl because the float pin was worn, and figured a sticking carburetor float would cause the trouble, so I put in a new float and float pin and took the truck out on a five-mile road test. She ran smooth as silk.

"Next morning—that was yesterday—Swinton phoned about a load that had to be delivered by 10 o'clock to a plant 30 miles away. I found it being put on '20.' I suppose I should have switched it, but '20' had run perfectly for me and was almost loaded.

"At half past 10 Swinton called again, and was he mad! The shipment hadn't arrived and was holding up the whole plant. Swinton called just after noon and was even madder. Our truck had showed up two hours late. The driver told him he'd been stopped five times by the same trouble he'd reported the night before. All I could say was that I'd get busy the minute the truck got in. Swinton snapped, 'You'd better get hot on it!' I knew that unless I did get hot, my job was gone."

"Well," Gus said comfortingly, "there are plenty of jobs."

"I don't want to lose this one—especially for incompetence," Tim protested. "But what Swinton said about getting 'hot' gave me an idea. We'd had our first trouble with '20' on the first day of this hot spell. Yesterday was even hotter—and we were having worse trouble. Vapor lock, I figured, must be the cause.

"The truck got back late, and the driver said it had stalled every few miles but that, after waiting about half an hour each time, he'd been able to start it again. I spent all evening trying to find some place where heat could cause vapor lock. The fuel pump and gas lines were well shielded—no doubt about that. But there was a hot-spot manifold that might heat up the down-draft carburetor, so I made a shield and heat deflector and installed it on the manifold. Then I rechecked the ignition and everything else I could think of, but couldn't find anything wrong. Finally I road-tested her—and she ran fine. That heat deflector I had made, I figured, had done the trick.

"This morning I sent No. 20 out with a load, but I told the driver to phone me right away if he had any more trouble. He called me before he'd been gone half an hour. I hurried right down. When I stepped on the starter, the engine took off without any trouble. We delivered the load and got back with the engine stalling every few blocks. The fact that she runs swell at night, but stalls in the daytime when it is hotter, makes me surer than ever that vapor lock

is the trouble. But I've worked my head off trying to find *where*."

"Where's the truck?" Gus asked.

"Right outside," Tim told him. "Shall I drive her in?"

"Don't bother," Gus said. "It's too hot. We can take a look at her where she is."

They went out and Tim raised the hood. Gus didn't touch anything, but his experienced eyes didn't miss anything. The horn, mounted on a cylinder-head bolt, seemed to interest him. He opened his mouth to say something; then changed his mind. Instead he took an old-fashioned wooden match from his pocket, snapped its head off with his thumb, and began to chew the matchstick.

"Well," Tim asked, "how about it?"

Gus, the match still in his mouth, climbed into the driver's seat. "Let's take a ride."

"O.K.," Tim agreed. He whistled to Dodger, and boosted him into the truck. Gus stepped on the starter. The engine took off promptly, and they headed up the highway. Then after a mile, the engine missed a few times and stopped.

Tim cut loose with a few choice expressions he had learned in the motorized artillery. Gus listened patiently until he had run down, and then nodded approvingly.

"That's real good language," he said. "Now suppose you hop out and see if the fan belt is tight."

"I know it's all right," Tim said, "but I'll look." He got out, and just as he raised the hood a blast of the horn made him jump. The horn kept blowing.

"There must be a short or a ground!" Gus yelled above the noise. "Look at the horn!"

Tim's head disappeared under the hood. Gus grinned and removed the match from where he had jammed it against the horn button. Tim's head reappeared. "I've got it!" he yelled. "Come down here!"

Gus climbed out. "The horn button jammed," he said.

"I don't mean that," Tim exclaimed. "I've found what's causing the vapor lock. See where that horn's mounted—practically in front of the carburetor! It shields the gas line from cool air coming through the radiator. When the motor gets hot, that heated line causes vapor lock. And look there!"

He pointed to a cylinder-head bolt two inches to the left of the one on which the horn was mounted. "See those marks? That's where the horn was before the truck went to the repair shop. The darn fools put it back in the wrong place."

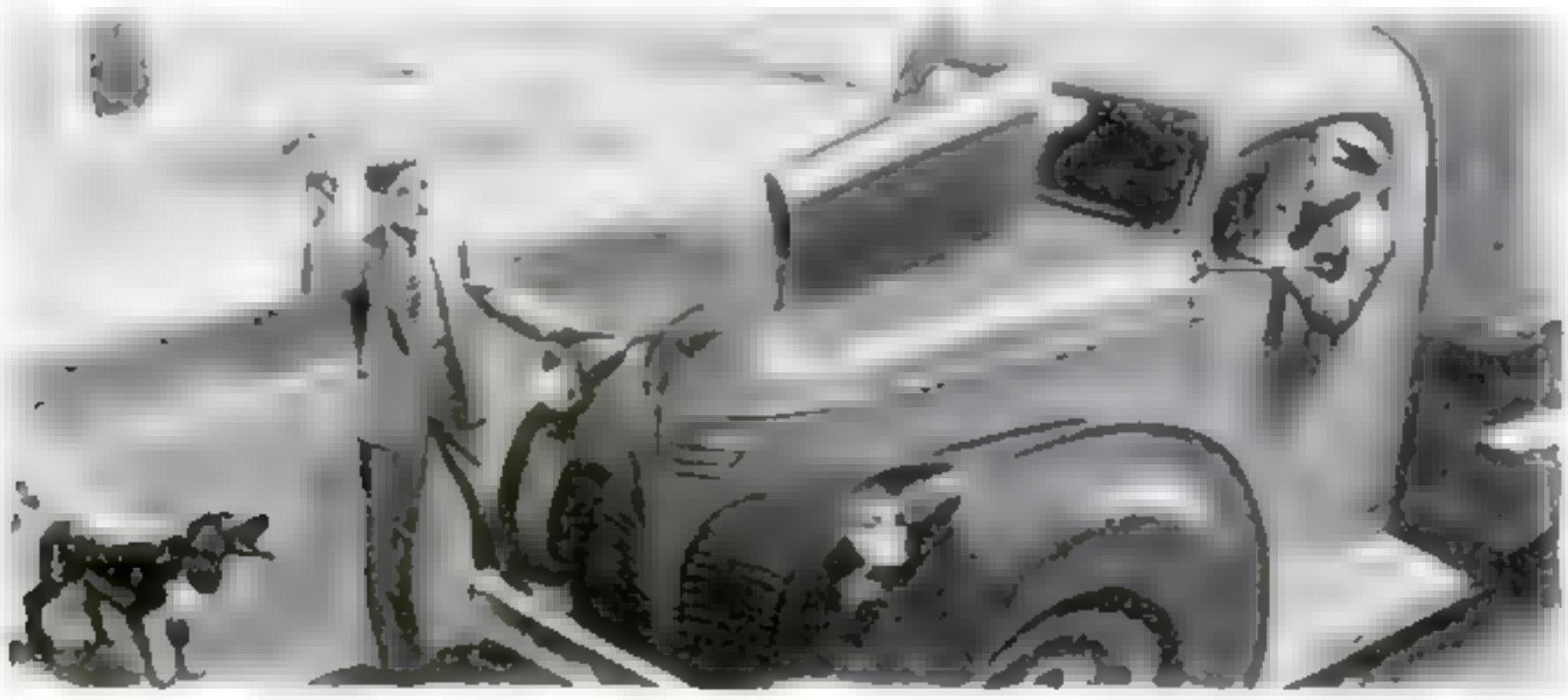
Gus got back into the truck and was joined in a moment by Dodger. He scratched the dog's shaggy ears. "Your boss isn't going to lose his job," he said, "but he was losing confidence in himself, and that's worse. Finding that horn mounted in the wrong place will build Tim Sheridan up with Tim Sheridan—that's why I didn't tell him when I spotted it!"

Sometime later Joe Clark heard his partner talking to Swinton about young Sheridan. "Run into trouble, has he?" he heard Gus say. "We all do that in this business. Being able to get out of it is what counts . . . Vapor lock? That's often hard to locate, but I'll bet you a dinner Tim finds it before morning. . . . You've got a good man in him—one of the best I've known, and believe me I've known a lot of 'em in my time."

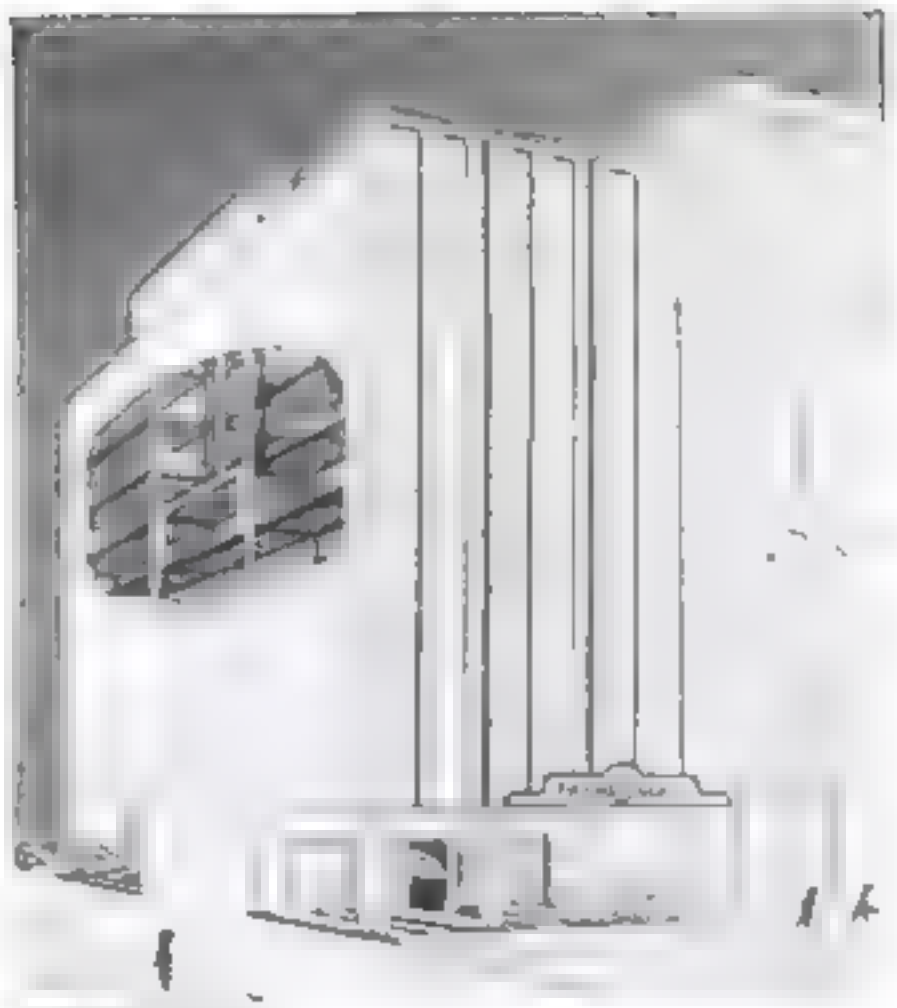
Joe grinned. "You're pretty good at blowing the other fellow's horn," he said when Gus hung up.

"I guess I am," Gus laughed. "That's twice I've done it today—and I got results both times!"

Tim's head reappeared from under the hood. "I've got it, Gus!" he yelled. "Come down here and see!"



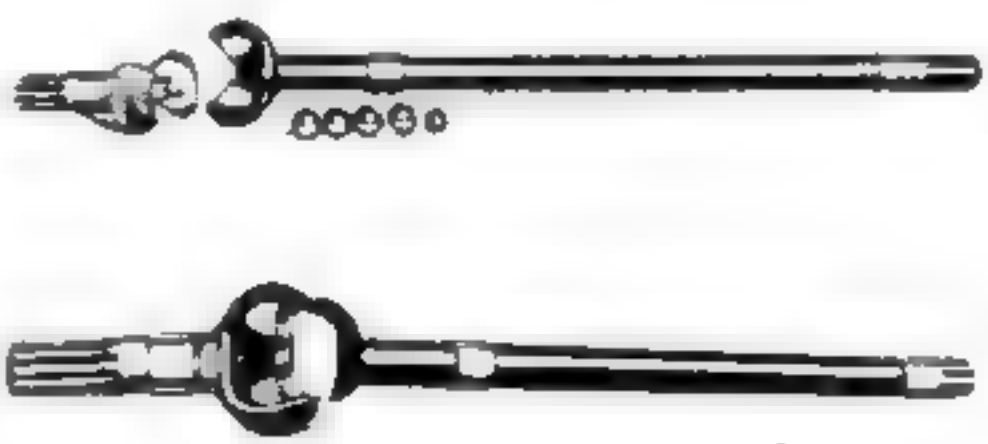
AUTO Ideas



AUTOMATIC PARKING with no handling of cars by attendants is to be provided for in a 12-level prefabricated building that can be set up on a plot 30' by 60'. A car is taken from the entrance by a device that grasps its bumper and slides it to an elevator, where it is carried to the designated level. There it is again taken by an automatic device and placed in an individual stall. A reverse process delivers the car at an exit. Every movement of the car from entrance to exit is controlled by one man punching buttons on a master panel near the door. The structure is to be made by the Park-O-Mat Company, of Los Angeles.

PART-TIME BUSES that serve as trucks when not needed for passengers are being used by the Navy and may be developed for civilian application after the war. Some 400 of these novel vehicles now move personnel and equipment in all 15 naval districts in this country. The bus-truck combination was originally a light-delivery unit for bulky loads built on a one-ton International chassis with a 113" wheel base. Side windows were cut and sash fitted in the man-high Metro body, and folding longitudinal side seats and removable center seats were installed in the 6' wide, 9½' long space behind the driver's seat. The buses carry 18 seated passengers and seven standees. In Navy service they average 10.9 miles to the gallon of gasoline while following schedules on regular routes.

A UNIVERSAL JOINT made by the Bendix Aviation Corporation, of South Bend, Ind., for jeeps and multiple-drive military trucks is a revolutionary departure from the type found in four-wheel drive cars before the war. The basic units of this Bendix-Weiss "constant velocity" joint are two yokes and five steel balls that transmit power from the differential to the driving wheels. They allow for a maximum angle of 37 deg. for steering, transmitting power uniformly at all angles. Their ball-bearing principle permits a simplified design that eliminates the sliding splines necessary to allow end motion in earlier joints made for the same purpose, thus minimizing lubrication and maintenance problems. The joints are so compact that they permit any desired surrounding construction and do away with the floor tunnel sometimes used in rear passenger compartments to give clearance for the propeller shaft.



Announcing the Winners

POSTWAR-KITCHEN CONTEST

JUDGES

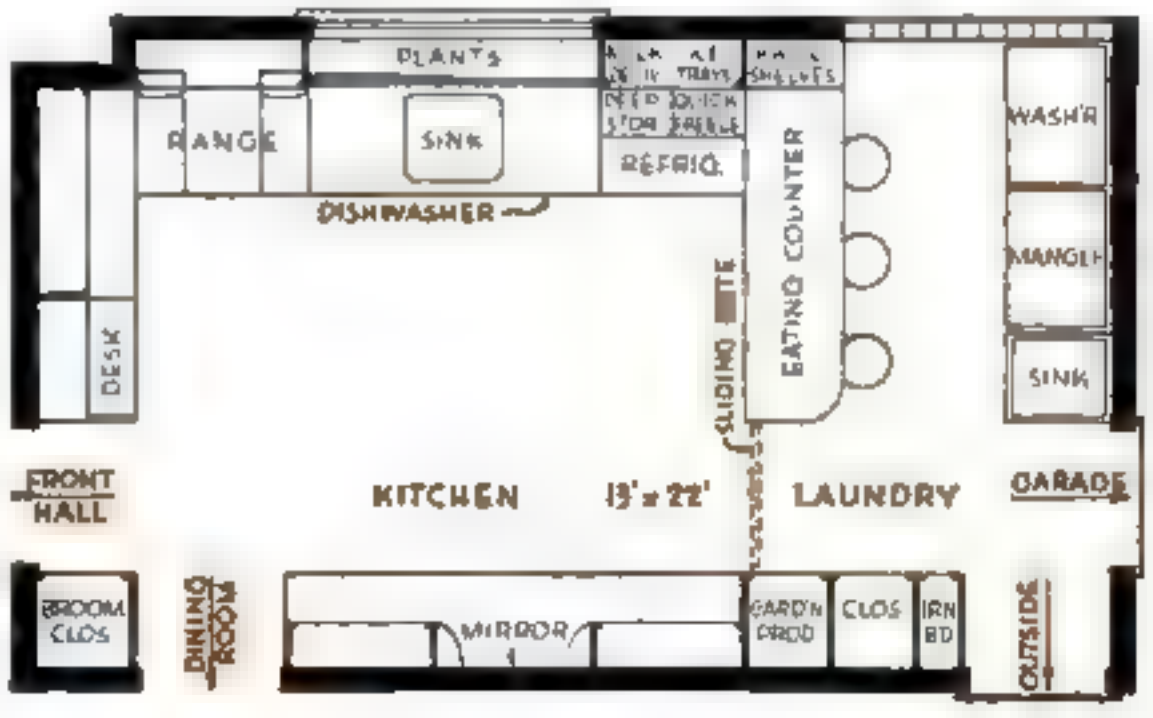
Adelaide Hawley, expert on home topics for newsreels and radio, Cameron Clark (standing), nationally famous architect, and Joseph Aronson, author and designer of interiors, examine the winning entry

RESULTS in the POPULAR SCIENCE Postwar-Kitchen Contest proved so unexpectedly good that the editors have raised the awards from the promised $500 to a total of $750. And the grand-prize winner, the unanimous choice of the judges, furnishes the surprise of the contest as well as a nearly perfect layout for an average family's postwar kitchen.

When the voting of the judges had been completed, and Mrs. Mary Lou Grace, of Ames, Iowa, had been found to be the unanimous selection, it was revealed that she was also the winner of POPULAR SCIENCE'S House-Planning Contest in 1941. Thus Mrs. Grace proves again her right to rank at the head of any list made up of amateur

1st PRIZE

Here are the winner and her plan. Mrs. Mary Lou Grace is shown in her present kitchen. She is a graduate engineer as well as a homemaker. For a description of her ideal kitchen in detail, see page 155



LIST OF PRIZE WINNERS AND THEIR AWARDS

FIRST PRIZE ($250) to Mrs. Mary Lou Grace, of Ames, Iowa.

SECOND PRIZE ($250) to Mr. and Mrs. Wayne Norton, of Muncie, Ind.

THIRD PRIZE ($125) to Mrs. Lillian C. Busby, of Melrose, Mass.

FOURTH PRIZE ($50) to Miss Elma DuPree, of Benton Harbor, Mich.

FIFTH PRIZE ($25) to Mrs. H. E. Walker, of Jeffers, Mont.

SIXTH PRIZE ($15) to Joseph Sward, of Los Angeles, Calif.

SEVENTH PRIZE ($10) to Yeoman 2/c Virgil Elsner, U.S.N., of San Francisco, Calif.

FIVE PRIZES ($5 each) to James. B. Rodgers, of Staten Island, N. Y.; Archie Young, Jr., of San Antonio, Texas; Richard Buehler, of New York, N. Y.; Capt. Earl W. Porter, R.A.A.F., of Roswell, N. M.; and Corp. John H. Lee, of Spanaway, Wash.

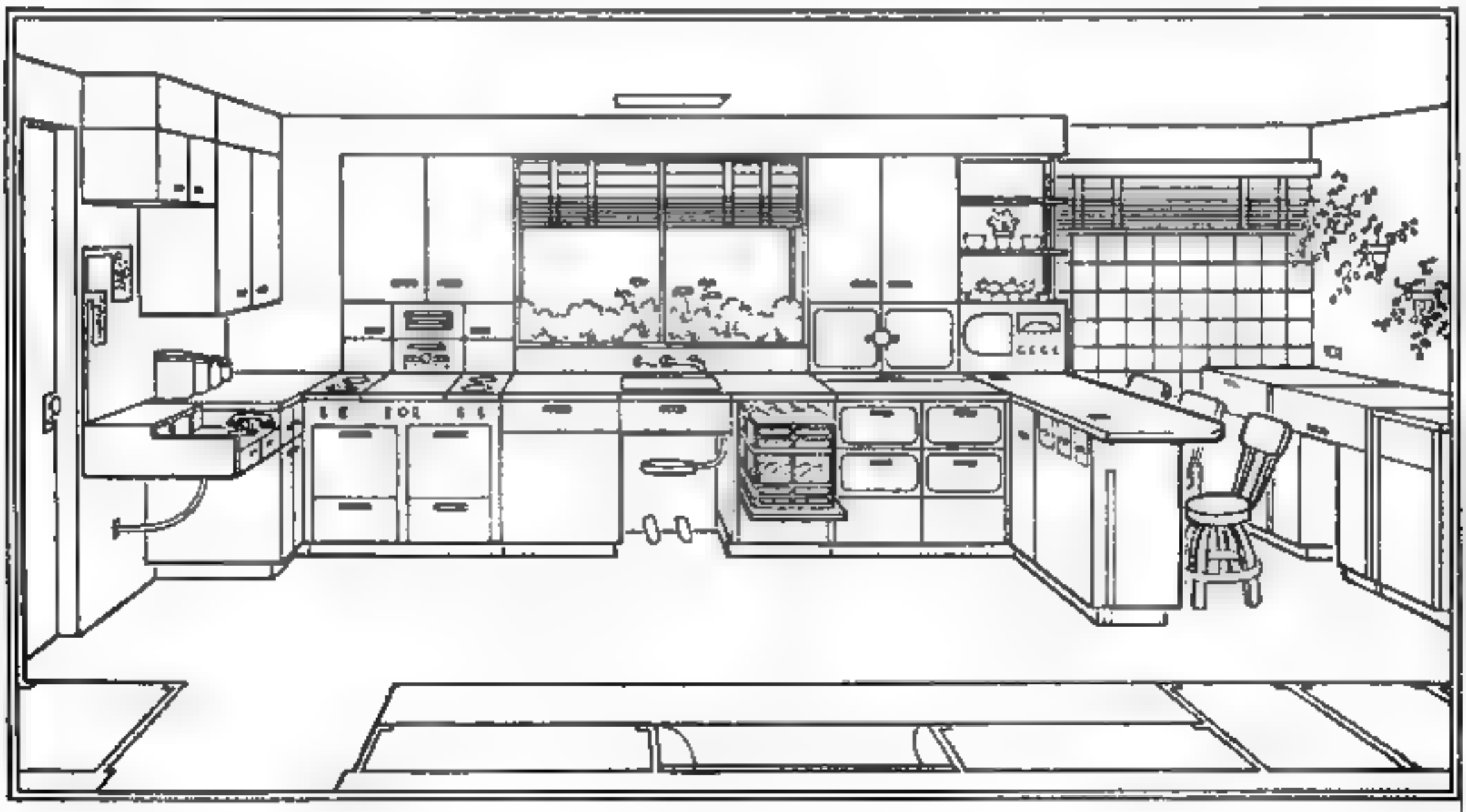
HONORABLE MENTION: Mrs. E. L. Long, of Sacramento, Calif.; Richard W. Norman, of Seattle, Wash.; S/Sgt. Edward Paul, of Fort Leonard Wood, Mo.; and Lewis C. Schumann, of Passaic, N. J.

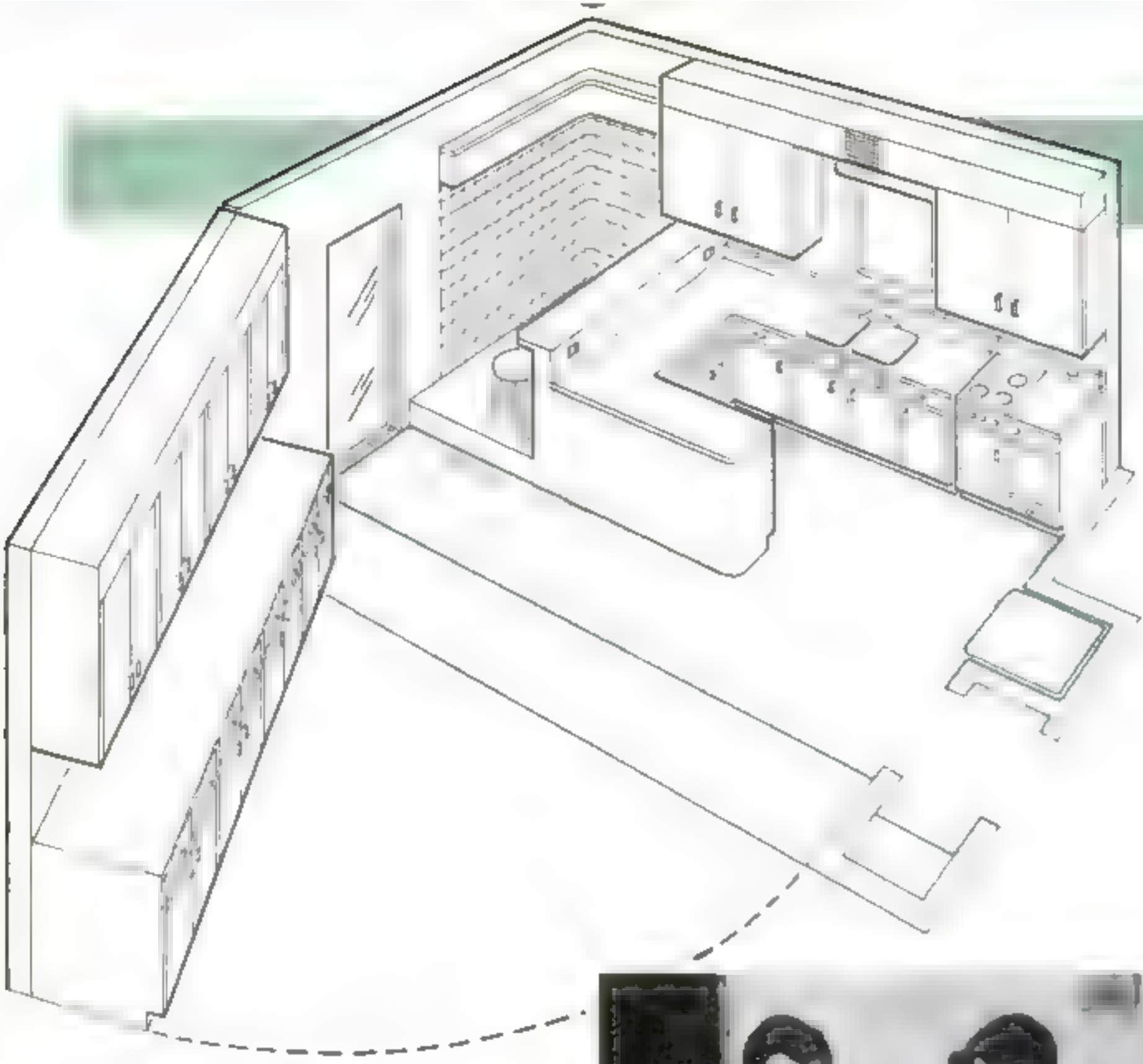
architects and interior-decoration planners.

Another two-time winner was Joseph Sward, of Los Angeles, who placed sixth. In the house-planning contest he won fifth prize. He also deserves special congratulations.

And now, because of the surprise furnished by Mrs. Grace, it is POPULAR SCIENCE'S privilege to provide a surprise of its own. The value of the second prize, won by Mr. and Mrs. Wayne Norton, of Muncie, Ind., has been increased from $125 to $250 and equals the award to Mrs. Grace; that of third prize, won by Mrs. Lillian Busby, of Melrose, Mass., has been made $125 instead of $50; the prizes have been similarly stepped up all down the line; and a twelfth prize of $5 has been added. All prize-winning entries were so uniformly good that they well deserve the increased awards.

Here is what the judges had to say about them. Cameron Clark, nationally famous





2nd PRIZE

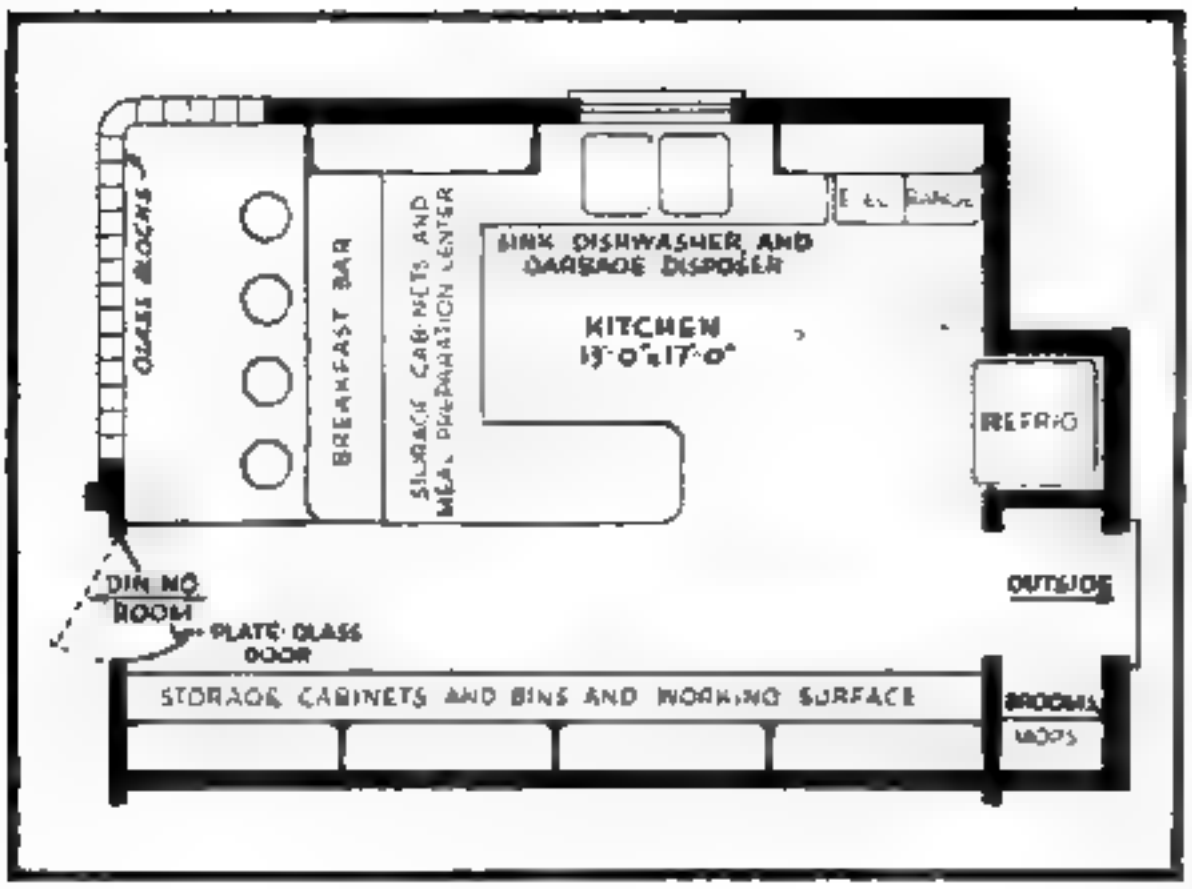
This is the young husband-and-wife team that took runner-up honors. Wayne and Berniece Norton look forward to the day when they can build their kitchen, shown with a side swung out in the drawing above. Their chief pride is the glassed-in, raised-floor breakfast bar

architect and designer of many show houses, writes: "The judges were unanimous in their choice for first prize. It was an outstanding arrangement of work space and kitchen units—a kitchen in which the housewife does all the work and where the family finds itself gravitating toward the house manager.

"The only missing unit would seem to be an enamel or marble-top center table. Counter tops do not quite seem to fill the need of a spot to drop hot cooking utensils. The sliding gate for the children's enclosure might be housed in the vegetable cupboard opposite the eating counter to release additional storage space. But these are very slight deficiencies."

Another of the judges, Adelaide Hawley, newsreel and radio commentator on home topics, writes: "My voting, I find, has been done on the basis of the kind of kitchen I myself would like to have and the kind of ideas that stimulate my thinking about better living conditions.

"My own ideal kitchen would combine, as many of these designs do, enough modern pieces to insure speedy, efficient work with a certain amount of old-fashioned homeyness and comfort. I'll even have a canary in a cage in the sun window.



How the Nortons' kitchen is laid out. The refrigerator is set in an alcove

"I will not have the place streamlined and mechanized to the extent that I have to stand helpless and wring my hands until the fixer arrives if some gadget stops working."

Joseph Aronson, who is well known to readers of POPULAR SCIENCE for his many contributions on furniture designs and interiors, including a notable series on renovating kitchens, also served as a judge. Mr. Aronson is a famous designer of interiors and is author of *The Encyclopedia of Furniture*. Concerning the Kitchen Contest winners, he writes: "The fact that all winners paid particular attention to correlation of storage and working space shows a native understanding of the principles of good design. Such details as storing food near the delivery entrance, and then following through with an arrangement of sink and stove, where food can be prepared and cooked with a minimum of wasted steps, all help to make a modern kitchen efficient.

"Most of the contestants also made good use of both natural sunlight and up-to-date artificial lighting equipment. Some of them chose color schemes that showed both good taste and an eye to increasing the value of the lighting."

That Mrs. Grace paid attention to these various details can be seen from the layout and drawing she submitted. They are reproduced on pages 154 and 155.

"This is the kitchen I want after the war —a kitchen that's really a room," Mrs. Grace says. "My kitchen is spread out into a comfortable 13' by 22' room where the whole family can safely inhale at the same time. There is no reason why equipment cannot be compactly arranged to save steps, provide plenty of work surface, and yet not interfere with ordinary circulation through the room.

"The plan combines kitchen, laundry, breakfast or snack counter, and play area. My laundry room may also be used as a play space for a small child by pulling out the panel that slides into the breakfast counter for concealment. This permits preparation of meals without stumbling over toys or child and still keeps the child in sight.

"There is plenty of sunlight in my kitchen, and for this reason I want dark work surfaces to avoid glare. The sink window is of sliding glass panels with a 1' space between for planting kitchen herbs and flowers. It is a large window so I can see plenty of sky, and the plants help keep passers-by from seeing inside. I use glass brick on the laundry-room wall to provide light and privacy for eating or laundering.

"Red linoleum covers the floor and has rounded corners. High toe space makes easy cleaning. Work counters and the table are black linoleum. The walls are cream ceramic tile, well soundproofed, and washable. I prefer wooden cabinets to metal, but they must really fit!

"I want a refrigerator built sectionally to permit opening of only the section desired and thus preserve the cold air. Drawers have the opening at the top and therefore lose less cold air since cold air flows down. Milk can be put in from the outside on delivery. There is a quick-freeze unit.

"The sink is high so the housewife needn't crouch to work, and it has plenty of work surface at both sides. Controls are floor pedals so water can be turned on even if both hands are full. The swinging stool at the sink permits sitting while cleaning vegetables. There is an electric dishwasher and a built-in garbage-disposal unit. To the left of the faucet is a soap dispenser, and to the right is an ice-water tap.

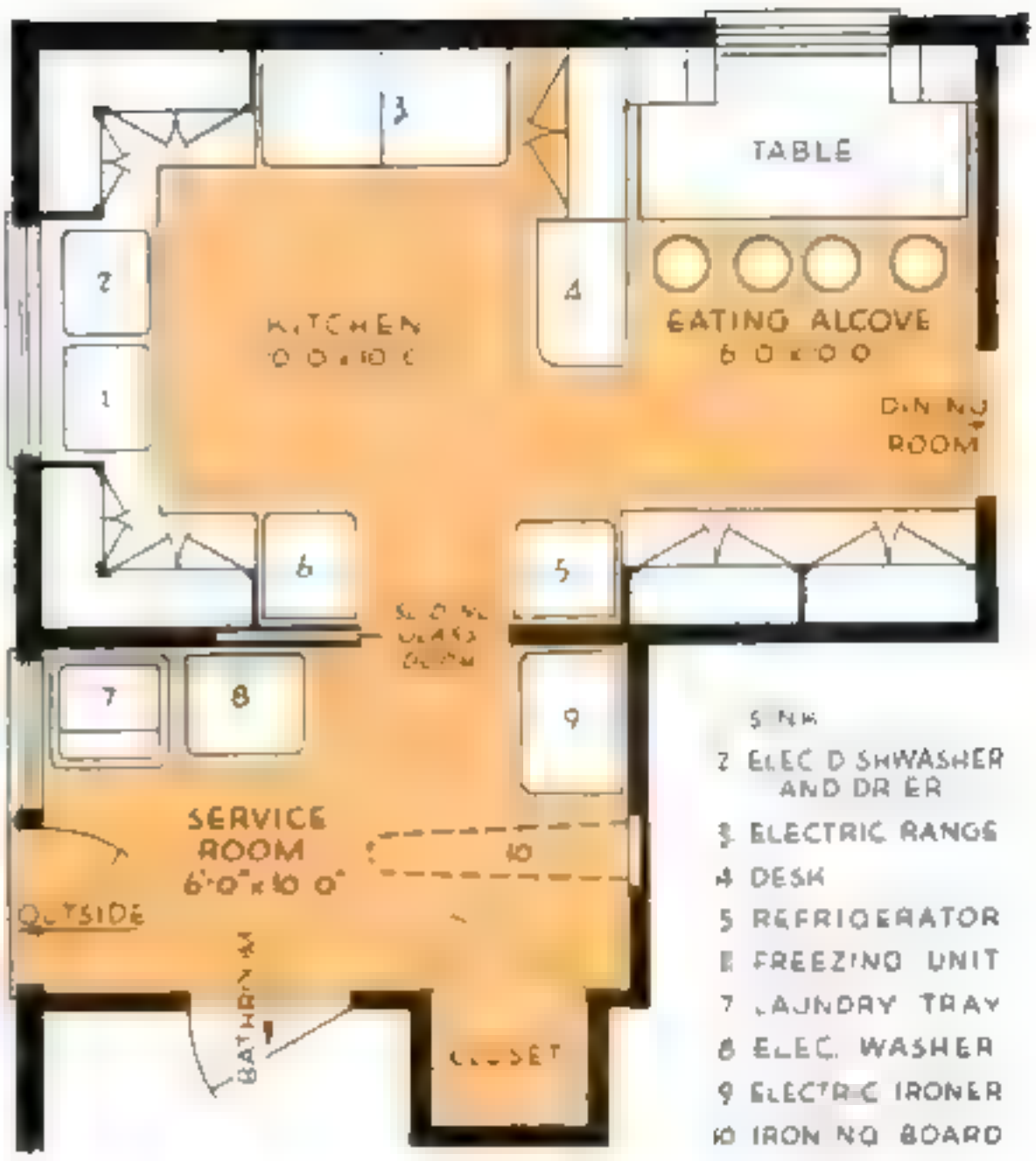
"I prefer a gas range, since that is what I am used to; but whatever type I have, I want the burners easy to clean and arranged two at each side so it won't be difficult to use all at the same time. Above the stove are two small built-in spice cabinets. The space between is for ventilation with a built-in fan behind the vent grille.

"There is a desk in the meal-planning center with drawers and shelves for recipes, files, bills, and an extension telephone.

"Lighting consists of indirect panels built

3rd PRIZE

Mrs. Lillian C. Busby, shown here with the plan for her kitchen, got her ideas from 30 years of trial and error. She is a housewife and has a hustling family that prefers a snack in the kitchen to a dining-room meal



flush with the ceiling over the sink, inner-wall cupboard, and desk, and there is a center light in the kitchen and the laundry. Two double wall plugs in each wall are at elbow height, and double plugs flush with the surface are at each end of the dining counter."

Berniece and Wayne Norton, who comprise the team winning second place, are among the youngest contestants to enter. Mrs. Norton is 19 years old and Mr. Norton is 21. Her hobby is sewing; his is his basement workshop. He is a draftsman for a tool company, and his ambition is to do architectural drawing and landscape planning.

"These are the plans for our intended kitchen in our intended dream house," the Nortons say. "The kitchen is 13' by 17'—not large but it takes in a breakfast bar and enough storage space for practically everything used in the home.

"We want the kitchen placed to receive the early morning sun through the east glass-brick wall and the southern sun the remainder of the day. The food preparation, cooking, serving, and cleaning centers are in the shape of a *U* having one short side to permit entry."

One of the features of the Nortons' kitchen is the alcove for the refrigerator. Another is the breakfast bar on a raised floor.

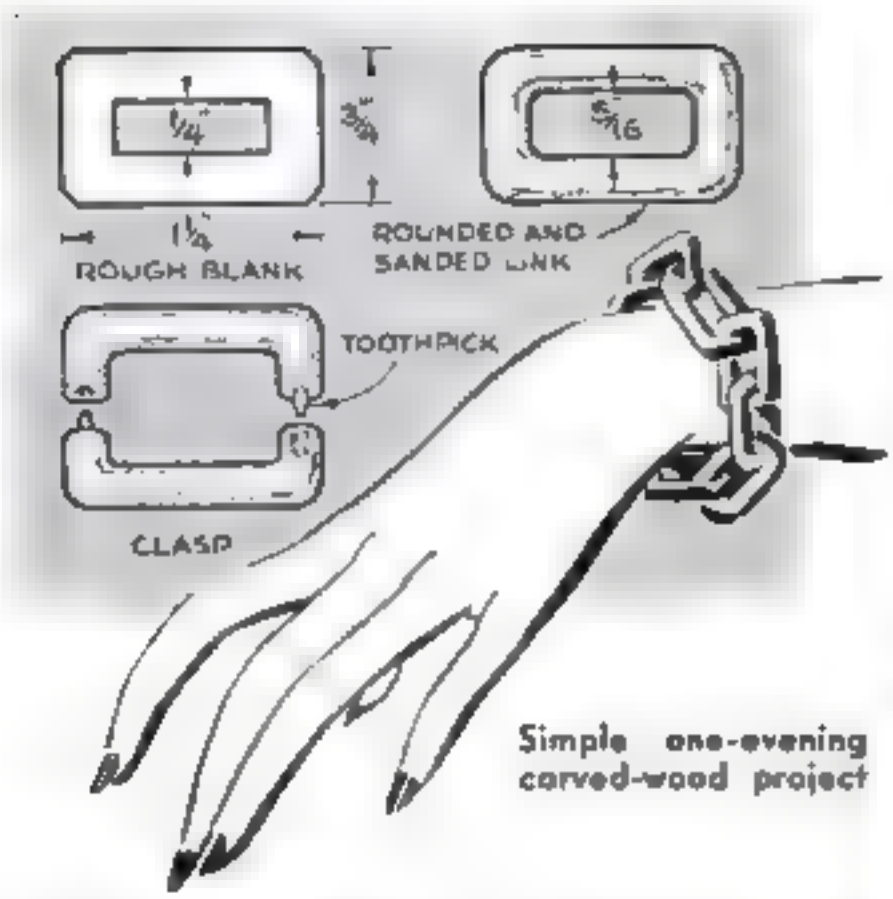
"In our minds this is the delightful part of our kitchen," the Nortons say of this bar. "It will be used for all meals except formal dinners. We intend to use it for informal parties and as a general entertainment corner in addition to meal serving."

The Nortons chose an electric range, as did Mrs. Busby, winner of the third prize. Mrs. Busby also plans to use her kitchen for more than cooking.

"A hustling family like mine enjoys a snack in the kitchen more than a ceremonious dinner in the dining room," writes Mrs. Busby. "So my postwar kitchen must combine an efficient domestic laboratory and an attractive eating area."

This eating section is separated from the kitchen proper by a 4' high serving bar having cabinets and a desk on the kitchen side. It also includes a table and chairs and a picture window flanked by shelves for ivy and begonias. In the kitchen, besides the range, which has a transparent door, there are an electric dishwasher and drier and an electric dish-towel drier. Mrs. Busby plans to have a dehydrating and quick-freezing unit separate from the refrigerator. The laundry is in an adjoining service room.

All the winners plan to use their prize money for the same thing –toward building their postwar dream kitchens. But until the war ends, they will help speed that day by putting their awards into War Bonds.



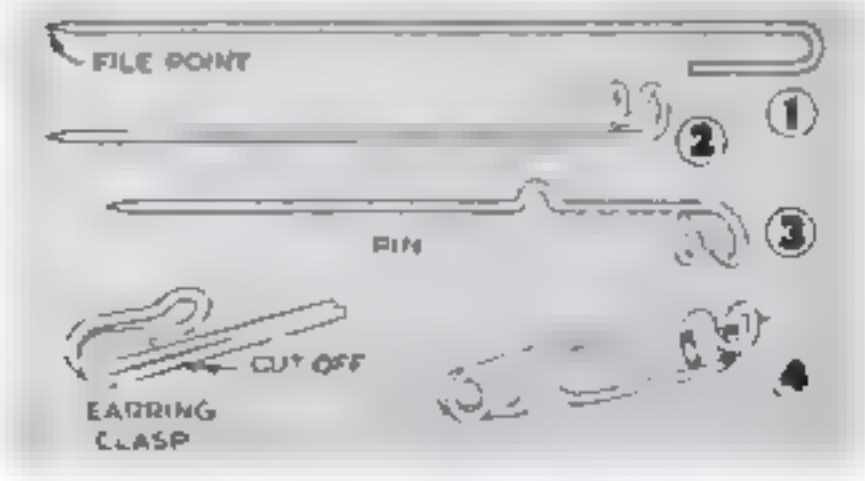
Simple one-evening carved-wood project

Chain Bracelet Is Hand Carved

SEEMINGLY carved from a single piece of wood, this bracelet is actually a simple one-evening project. Each link is prepared separately; then every other one is split open and rejoined by gluing it around the adjacent solid links. Cut 12 blanks from ¼" hardwood stock, taking care to have the grain running lengthwise. Round the edges; then sand smooth. Split the alternate links, assemble, glue, and dry the glued joints under pressure. The clasp—the 12th link—is cut into two pieces. One piece is slightly larger than the other to make the bracelet easy to put on. Drill a 1/16" hole in each end of each piece. Make the plugs of round toothpicks, which should be sanded down slightly to provide the correct amount of friction for holding the clasp firmly. Shellac and wax make a simple and serviceable finish.—KENNETH GUEBERT.

Paper-Clip Jewelry Fasteners

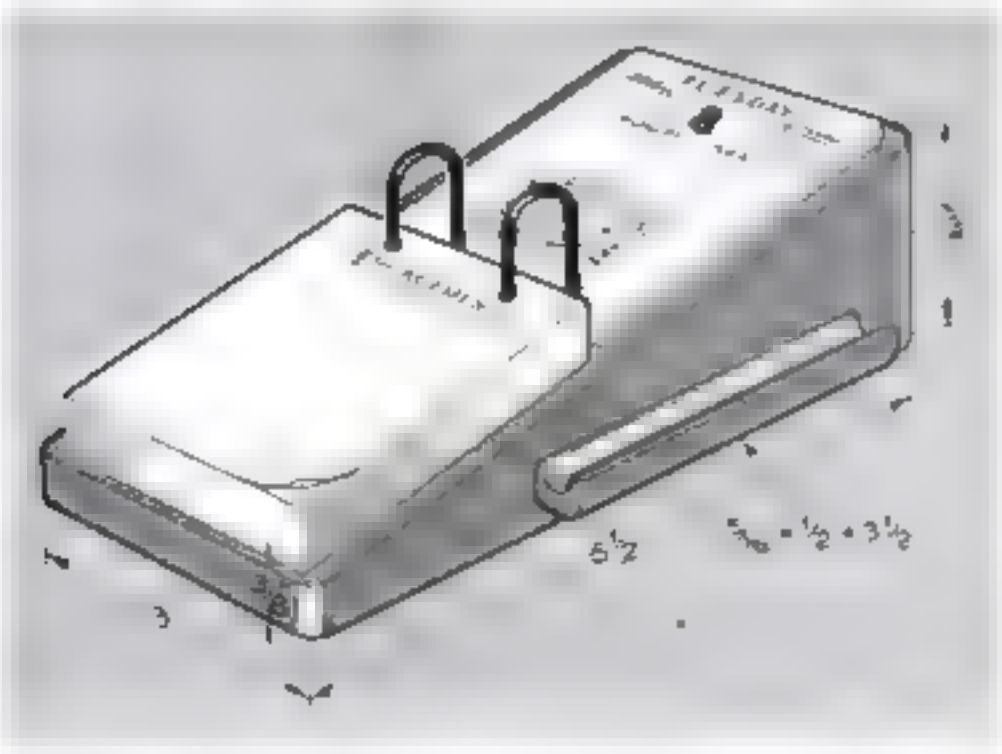
EARRING clasps and brooch pins, for mounting handmade jewelry, can be shaped from common paper clips. The earring clasp, as shown below, is simply a loop of wire that is cut and soldered to the back of an earring. To make the brooch pin: first, straighten all except the small loop of a clip and file the end to a point; second, bend the small loop into the shape of a hasp; third, crimp the remaining leg to form a pad to be soldered to the brooch; and fourth, form the coil spring and set the filed point in place under the hasp.—HARRY FLASTER.



Powder-Puff Placecard Favors

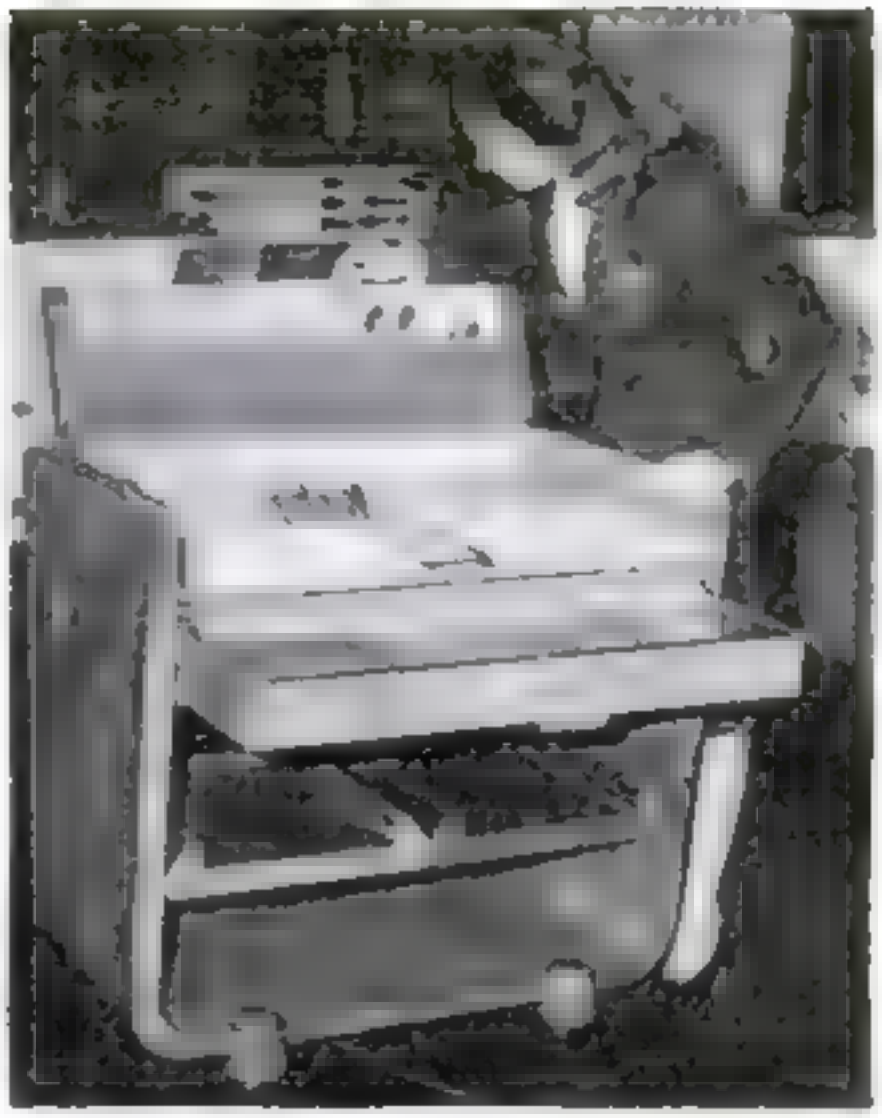
INEXPENSIVE placecard favors can easily be made. The little lady at the right has a powder-puff hat, trimmed with ribbon, and a powder-puff dress. Her head and body are two beads; her legs and arms are lengths of pipe cleaners held on with glue.—B. N.

Easy-Vision Calendar Pad and Pencil Holder Is Simple to Make



HARDWOOD or white pine, finished to match your desk, is used in making this pad. The dimensions given are for a 2⅝" by 3⅛" calendar, but can be changed to fit any other size. The unit looks best if sheets for only six months at a time are placed in it. Two grooved strips are glued to the main block. Two U-shaped lengths of No. 8 wire are formed around a ⅛" dowel, then driven into ½" deep snug-fitting holes that have been drilled into the base block. If the wires are not chromium or nickel-plated, they should be given a protective coat of paint, enamel, or lacquer.—JENNINGS A. MASSINGILL.

STAIR TREADS made of an asphalt and felt composition are on the market. Manufactured by the So-Lo Works, Inc., of Loveland, Ohio, they are said to look, feel, and wear like rubber. The treads are waterproof, have a nonskid surface, are easy to apply, and are made in both a flat and a nosing type. They can be cemented to wood, metal, concrete, or other materials with a special cement made for the purpose.



POSTWAR KITCHENS may include serving wagons similar to that developed by the Libbey-Owens-Ford Glass Company, of Toledo, Ohio. This wagon carries linen, silverware, and china. It has a food-warming compartment that can be plugged into a socket in the kitchen or the dining area. When not in use, it occupies its own niche.

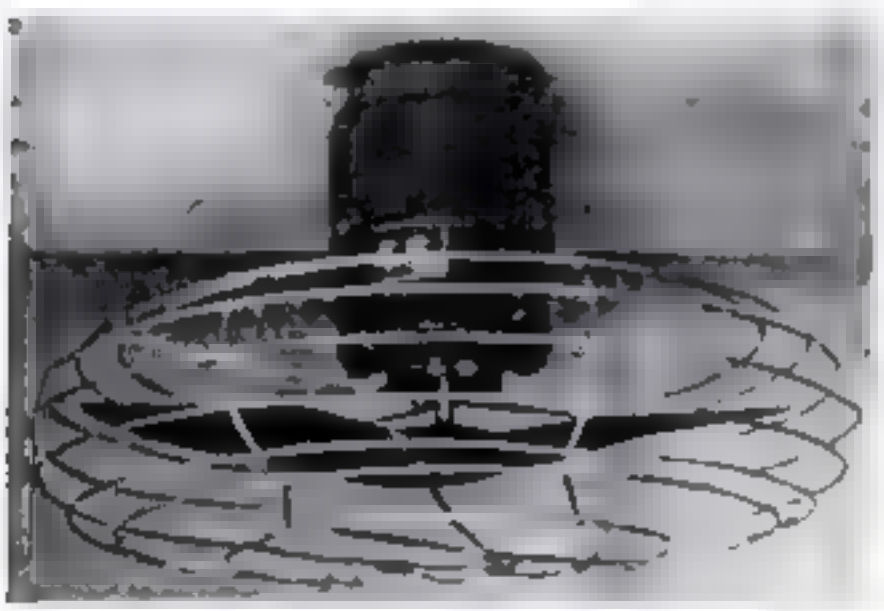
Left no awkward stooping is necessary to get at the oven When down, the ironing board reveals handy storage shelves

ENGLISH ELECTRICAL ENGINEERS have their own ideas of what the postwar kitchen will look like. One conception is this laboratory-like all-electric demonstration model, recently displayed at the Poplar Electrical Showrooms, in London. Included are a washing machine with wringer, a stove, an oven, a built-in ironing board, a refrigerator, a ventilating blower system, an electric clock, indirect lighting, and generous storage space.

In his shop, Schwartz prepares one of the transparent mirrors, using a hose to spray his secret coating on the glass. Right, a finished mirror is being examined

THROUGH THE LOOKING GLASS is not only the title of a book but also a method of observation. Using a secret formula, Isadore Schwartz, New York City glass manufacturer, produces a mirror that allows the initiated to inspect other people through it without in turn being seen.

Like ordinary mirrors, his are coated on but one side. The ingredients of the formula are known only to Mr. Schwartz, but he has revealed that it contains no shellac. In use, one of the mirrors is set in a wall between two rooms. If both rooms are equally lighted, the glass is transparent from both sides. However, if one room is brighter than the other, occupants of the first room can be observed from the second, while they can only see reflections.



FLIES OR MOSQUITOES are baffled by an invisible barrier of air that is blown across an opening by this device, known as the Reco Fly-Chaser Fan. People, however, may come and go at will because the air blockade, although big in volume, is gentle in motion. The fan is equipped with a two-bladed Bakelite impact-resistant propeller that is 20" in diameter. It is said to be an effective guard for any opening—for instance, a door, a window, or a chute—that is at least 4' wide. Hospitals, restaurants, food stores, dairies, and food-processing plants are using the device.

VICTORY GARDENERS will be interested in this carry-all made of nonessential hardwoods and given a natural finish with red trim. The manufacturers, B. C. Jarrell & Co., of Humboldt, Tenn., claim that it is strong enough to handle a 75-lb. burden, durable, economical, and easy for women to handle because it weighs only 7½ lb. It seems well suited for use as a general garden and utility cart.

NONSHRINKABLE CEMENT is once more available in metal containers now that WPB restrictions have been eased. The white-powder crack filler and tile-repair material, manufactured by the X-Pando Corporation, of Long Island City, N. Y., expands as it sets, forcing its way into pores and irregular surfaces. It may be colored by dry pigments or by using a penetrating finish after it has hardened.

Saboteurs in

Larvae of the Mexican bean beetle (above and below) and an adult beetle (at the right below), costly garden pests . . .

. . . and here is the work of the bean beetle, a badly eaten leaf. Its damage to our bean crop amounts to $730,000 yearly. Lethane-rotenone mixtures prove deadly to the pest

BUT for the work of American chemists, war would have let loose a horde of food-destroying insect pests on our farms and gardens. The corn-ear worm in a single year destroys enough sweet corn to fill 24,000,000 cans. Three types of aphids each year pilfer from our tables peas, melons, and turnips valued at many millions of dollars. The Mexican bean beetle turns in his bill for damages to the tune of $730,000.

In the past few years our most effective weapons against this insect army have been the contact poisons—organic compounds harmless to men and animals but deadly to many insects. The basis of most is rotenone.

CABBAGE WORMS render an annual bill for $4,000,000, spoiling 20 percent of all cabbage grown by chewing up the tender leaves and stunting the growth of plants. Lethane-rotenone mixtures are effective agents in combatting them

Your Victory Garden

Experts say we could use 10,000,000 lb. of rotenone-bearing roots of tropical plants every year. We never managed to import more than half that, and of what we did import 60 percent came from Malaya.

Rotenone, however, has been used only about 12 years now, and long before that American chemists had set to work to develop synthetic organic poisons for the war on insects. Organics like rotenone, pyrethrin, and nicotine—called the "botanicals"—vary according to climatic conditions, are unstable in storage, and lose strength rapidly after spraying or dusting. The chemists tried by juggling molecules to find new insecticides that would be stable, of measurable killing power, and long-lasting but harmless to humans.

NNO, a wetting agent that spreads in an even, weather-resisting film, was developed by chemists of the Atlas Powder Company from one of the hexahydric alcohols. Used with rotenone, it checks soft-bodied insects infesting greenhouse plants. Combined with pyrethrin it is deadly to leaf rollers and leaf tyers. Tests have shown that it will make a given amount of rotenone do double duty.

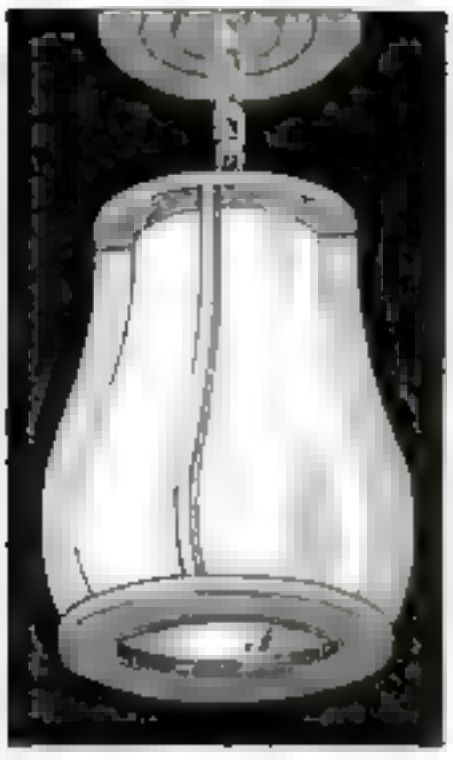
The Lethanes, a series of thiocyanates developed by chemists of the Rohm & Haas Company, are such efficient rotenone stretchers that they are rapidly becoming the basis of many new agricultural insecticides. Vegetable growers have found that a three percent addition of Lethane 60 cuts their rotenone needs to one quarter. In Florida, Pennsylvania, and Long Island field tests one powder containing Lethane ran up a box score of 95 percent against bean aphids, where the highest proportion killed by rotenone dust was 68 percent.

ARMY WORMS wreak havoc with crops, especially in the South where several generations appear in one season. They are used in the Rohm & Haas laboratories for testing new deadly insecticides

APHIDS, like these in a cluster on a nasturtium stem, are enemies also of food crops. They feast on peas, melons, turnips, beans, and potatoes. Lethane powders are used against them

SQUASH BUGS are a tough lot when they grow to the adult size shown in the close-up below and are resistant to contact poison. but sprays and powders are used with telling effect on the young

Porch Lamp Is Made from Oil-Lantern Globe



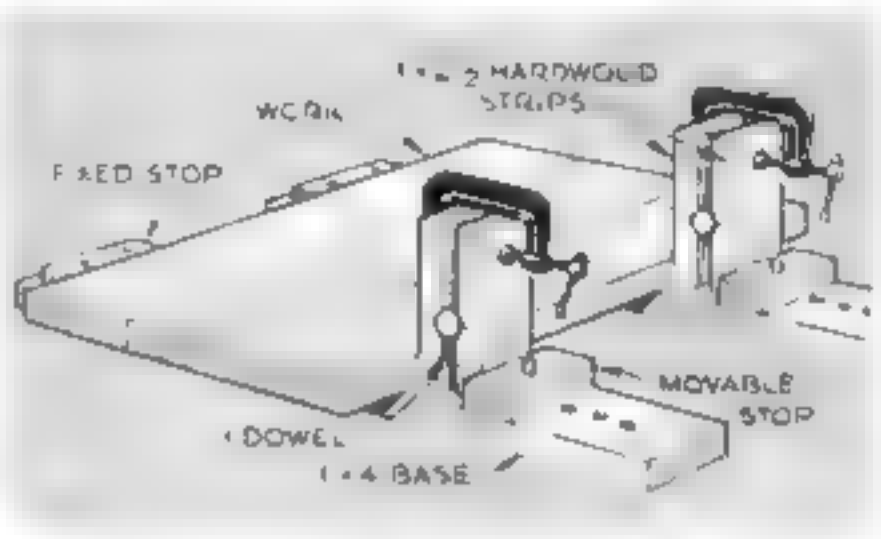
INEXPENSIVE to make and attractive in appearance, this porch lamp consists of a globe from an oil lantern, the chain-and-socket fittings from a discarded lamp, and a few scraps of ¼" plywood.

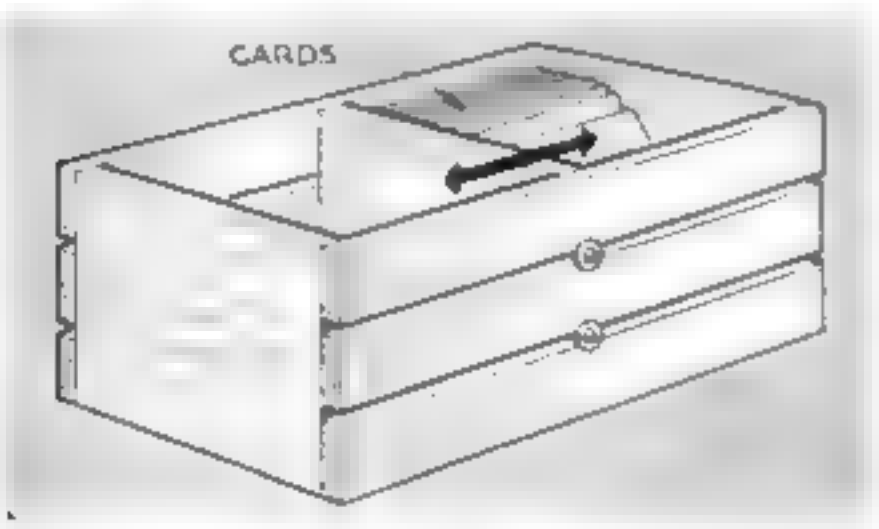
Trace the profile of the globe on a piece of stiff paper or cardboard and cut it out. Using this as a template, make four wooden struts ⅝" wide. Next, cut out the bottom ring, making its inside diameter the same as that of the bottom of the globe and its outside diameter 1⅛" larger. Make the top ring assembly of three thicknesses of the wood, drilled to take the cord. The bottom thickness has a hole in it to fit over the top of the globe. The ceiling pad also is made of three ¼" layers. Use small brads and glue to assemble the parts.

Coat the inside of the globe with a mixture consisting of three parts of orange shellac and one of turpentine. Apply one coat of shellac and two coats of black enamel to the wooden pieces.—MARC RODRIGUE.

Gluing Jig for Large Work Utilizes Two Small C-Clamps

TWO small C-clamps are used in this jig to hold together a large glued assembly while it is setting. The clamps force together the heads of pairs of hardwood strips that are separated by 1" dowels. One foot of each pair presses against an adjustable stop that is held in place by a bolt or short rod set through it into a base. The foot of the other strip pushes against the work, which is held at its opposite edge by fixed stops. The dowels may be moved up or down to vary the leverage.—RONALD EYRICH.



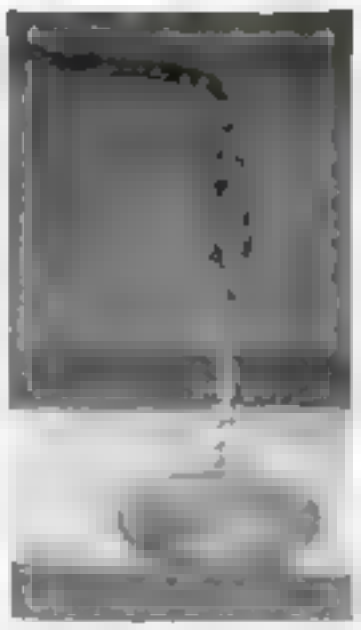


File Holds Odd-Sized Cards

FOR filing photo negatives or cards that do not fit in standard file drawers, the box shown above is handy. Each side consists of three strips, spaced far enough apart to allow the shank of a roundhead screw to slide easily between two adjacent strips. Put a washer on each screw before pushing it through its slot; then drive each screw into the sliding partition.—B. BROWNOLD.

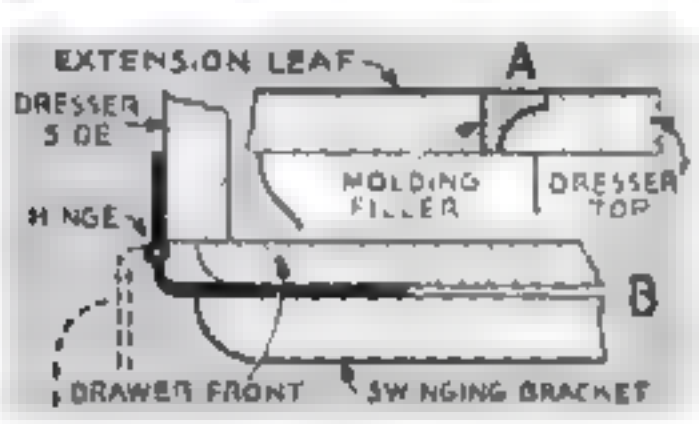
Mirror Aids in Hand Drilling

IF YOU want to be sure that vertical holes you drill with a brace and bit or a hand drill are true, place a flat mirror as close to the bit as possible. If even the slightest angle shows at the intersection of the bit with its image, the hole will not be vertical. Try the mirror at two places 90 deg. apart.—W. SWALLOW.



Formula for Homemade Putty

PUTTY for all-around use may be made by mixing together white-lead paste, whiting, and spar varnish. It should be of the consistency of medium dough. To make it set properly, add a little drier.—JOSEPH E. BIRD.



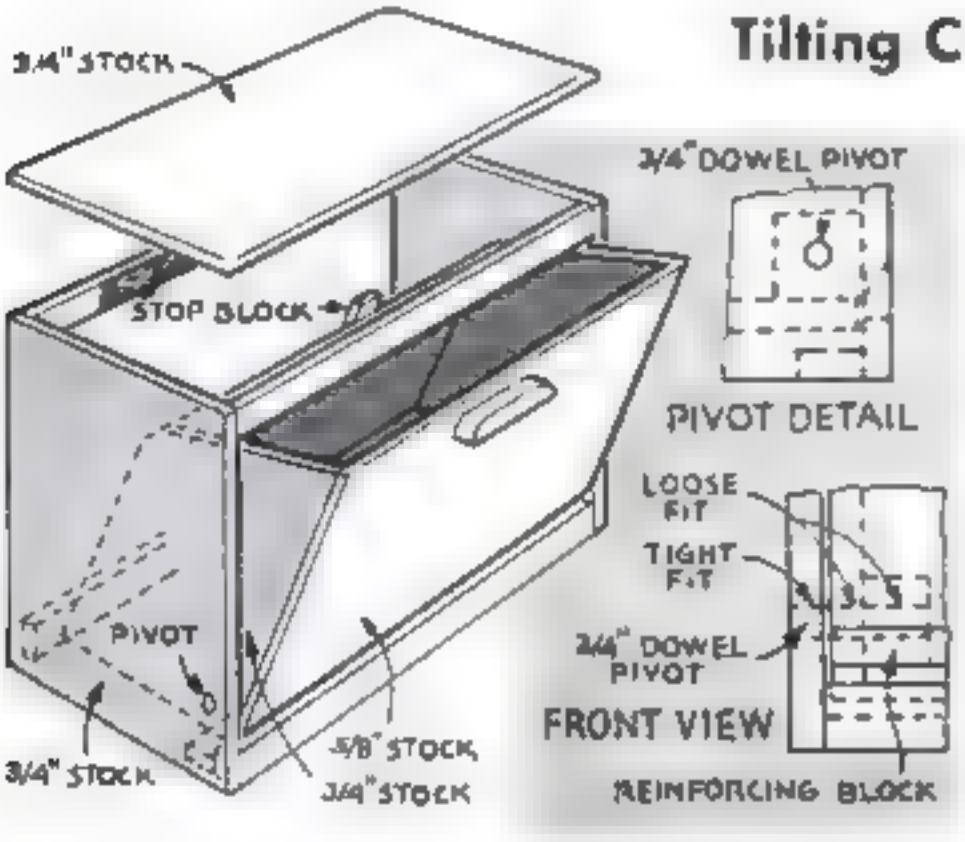
Young Lady's Vanity Is Made from Child's Chest of Drawers

IF YOUR little girl has reached the age where she objects to using juvenile furniture, her child-size bureau may be made over into this young lady's vanity table.

Where the chest top has a molded edge, add a filler, as shown in Section A. Next add two semicircular extension shelves, held in place by wooden braces. Two swinging brackets, for holding the draping at the front, are then hung on hinges that are fastened to the sides of the chest (see Section B). If a kneehole is desired, remove all but the top drawer and its supporting rails.

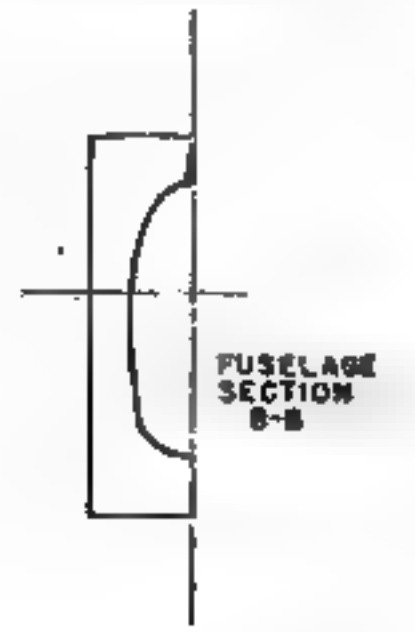
The mirror, renovated with cold-water paint and some Peter Hunt brushwork (see P. S. M., Sept. 1943, p. HW 416), is mounted on two uprights that are screwed to the back of the chest. The curtain-material draping is backed with sateen of a color to suit the room.—MICHELE DE SANTIS.

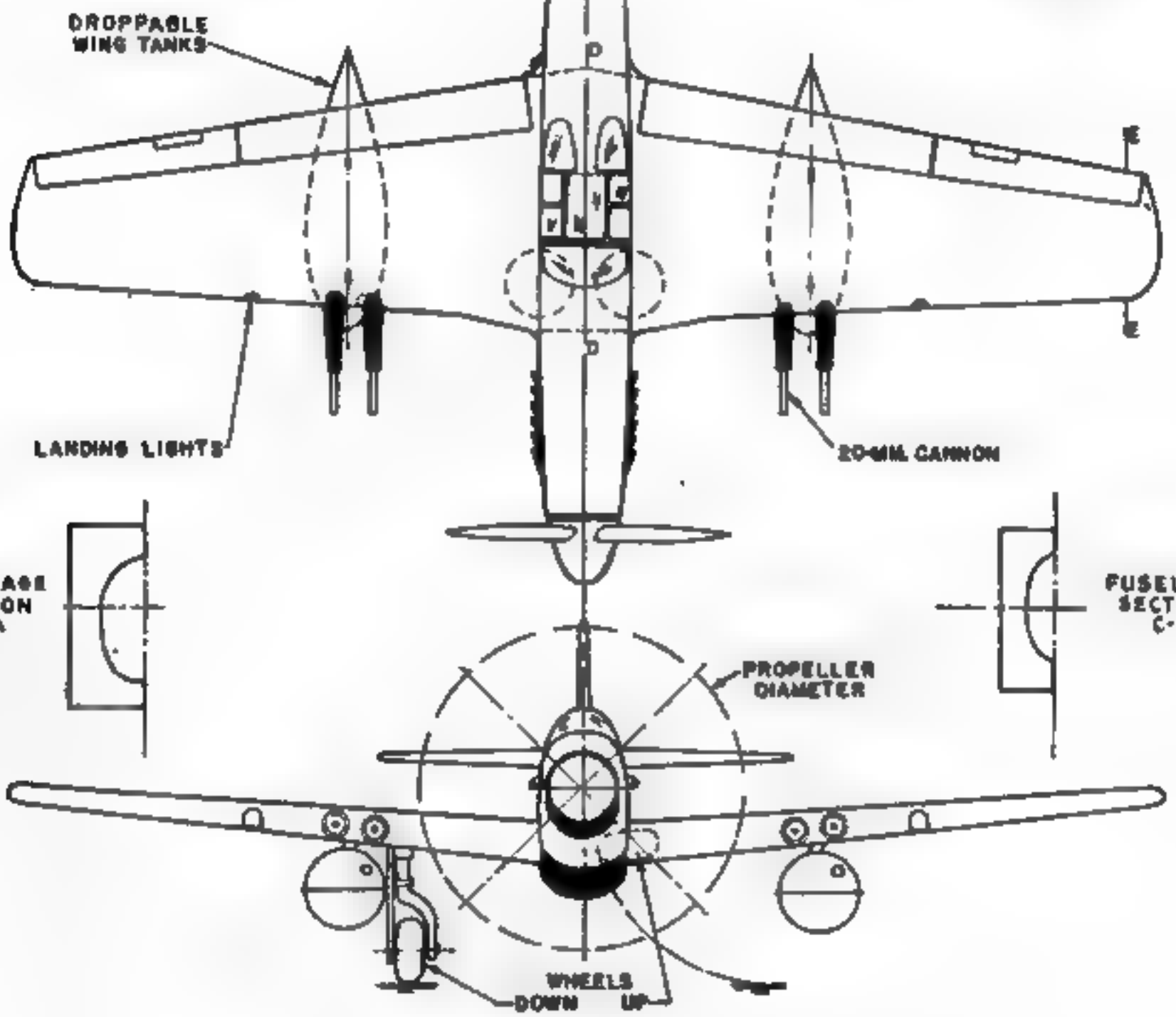
Tilting Clothes Hamper Is Well-Ventilated

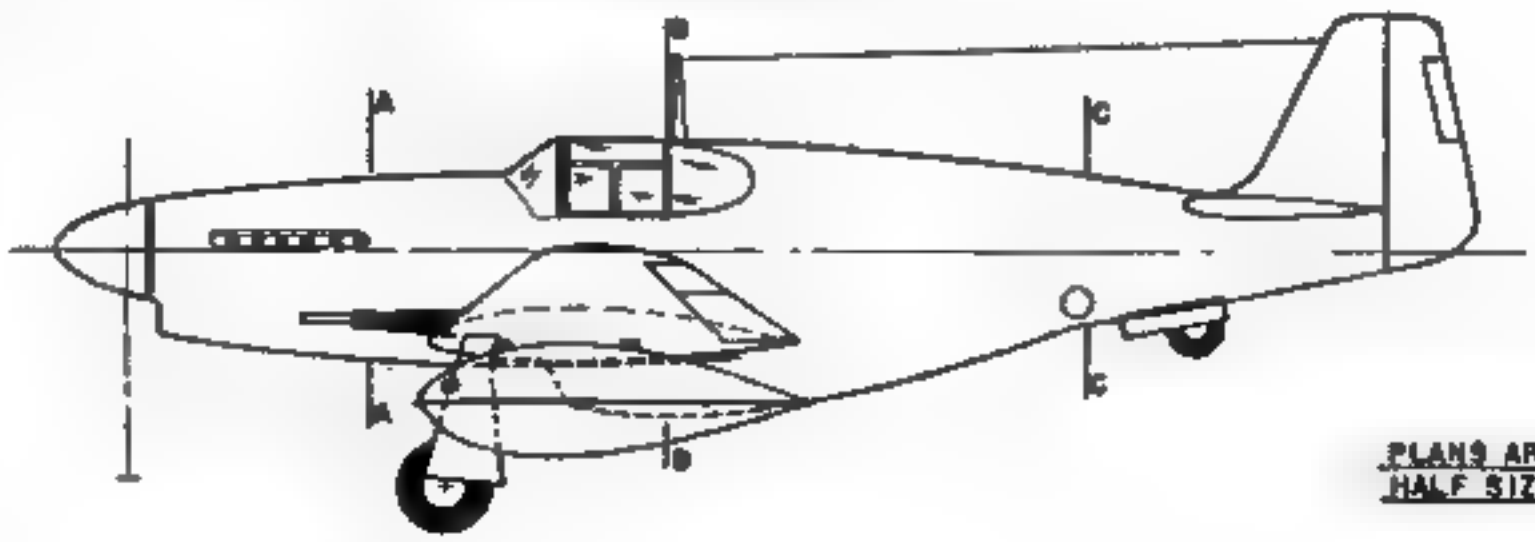


FEATURING a tilting bin for easy access and an open back for ventilation, this clothes hamper may be stored under a sink or shelf. Make the casing sides, bottom, and top of ¾" stock, dressed and squared to the desired dimensions.

Plan the outside dimensions of the bin so there will be 1/32" clearance all around between it and the casing. Its front, of ⅝" stock, is glued up to prevent warping. Its sides and bottom are similar to those of the casing. The back may be made of plywood. Hang the bin on two lengths of ¾" doweling that are tightly driven through holes in the casing. Add two blocks to reinforce the bin at the holes.—W F.







PLANS ARE
HALF SIZE

1/2

NORTH AMERICAN "MUSTANG" P-51

SCALE-MODEL MUSTANG

This Solid Replica of a Hot USAAF Fighter Job Is Easy to Build

AUTHENTICALLY scaled down to 1/48th the size of the original, this model of the North American P-51B Mustang fighter makes a simple and attractive project. The Mustang has a 1,500-hp. liquid-cooled Rolls-Royce Merlin engine and features a laminar-flow wing, which is largely responsible for the top speed of over 420 m.p.h.

The first step in building this miniature reproduction is to make a full-size working drawing. The plans reproduced at the left are half size. Using the border graduations as a guide, draw horizontal and vertical lines to form a grid of ¼" squares. Draw a similar grid on a large, stiff sheet of paper, increasing the size of the squares to ½". By matching squares, transfer the lines from the smaller drawing to make a new, larger drawing. Shapes can then be traced from this drawing onto another stiff-paper sheet and cut out to form full-size patterns or molds of the outlines and sections.

Use either white pine or balsa for the fuselage, wing, and tail. The fuselage block is ⅝" by 1⅝" by 7⅝". Transfer the profile to the block; then cut away the excess wood. Do the same with the plan view. Next, carve and sand the block to the proper cross-sectional shape, frequently checking it with your patterns. Finally, cut a hole in the fuselage to take the one-piece wing.

The wing block is 7/16" by 2¼" by 9½". Taper the thickness to 3/16" at each end. Trace the plan view of the wing on the block and cut away the excess wood. Carve and sand the block until it conforms with your sectional molds, rounding the tips neatly. Form the dihedral angle by scoring the top surface on the centerline and cracking the wing at that point. Set the cracked wing to the proper angle and apply cement to the crack.

Make the stabilizer and the fin of 3/16" material—tracing, cutting, and shaping them as described above.

Cement the stabilizer to the fuselage and allow the assembly to dry; then glue on the fin. Slide the wing into position and glue it in place. Carefully check the alignment of each part as it is installed. Fill all the crevices with either plaster of Paris or wood putty, and sand smooth when dry.

Apply two coats of surface-filling paint to the entire model, sanding between coats. Finish the lower surface with a coat of light-blue camouflage paint and the upper surface with a coat of olive drab, blending the colors in an uneven line.

Finally, add the external details, such as the wing tanks (mounted with pins), a celluloid disk to simulate a revolving propeller, and the cannons. Make the cockpit and control-surface outlines with a ruling pen and black ink.—BILL SPRAGUE.

HAMBURGER EXPRESS

BILL BROOKS is a believer in individual enterprise and originality. Formerly in the advertising business, he now operates a one-man railroad near Detroit. His road hauls only freight; it runs on a two-track semi-circular roadbed laid on the counter top in his eating place. The Coffee Bar Flatcars, pulled by model locomotives and trailed by cabooses, carry hamburgers, cheeseburgers, and pie from kitchen to customer, and used dishes from customer to kitchen. Cigarettes are carried in gondola cars.

Brooks, a versatile man, runs both the restaurant and the railroad single-handed

In the unique eating place shown below, a model railroad hauls food freight to the patrons. Food is prepared in the kitchen by owner Bill Brooks, right, and hauled to clients, who help themselves

$50 DOWELCRAFT CONTEST

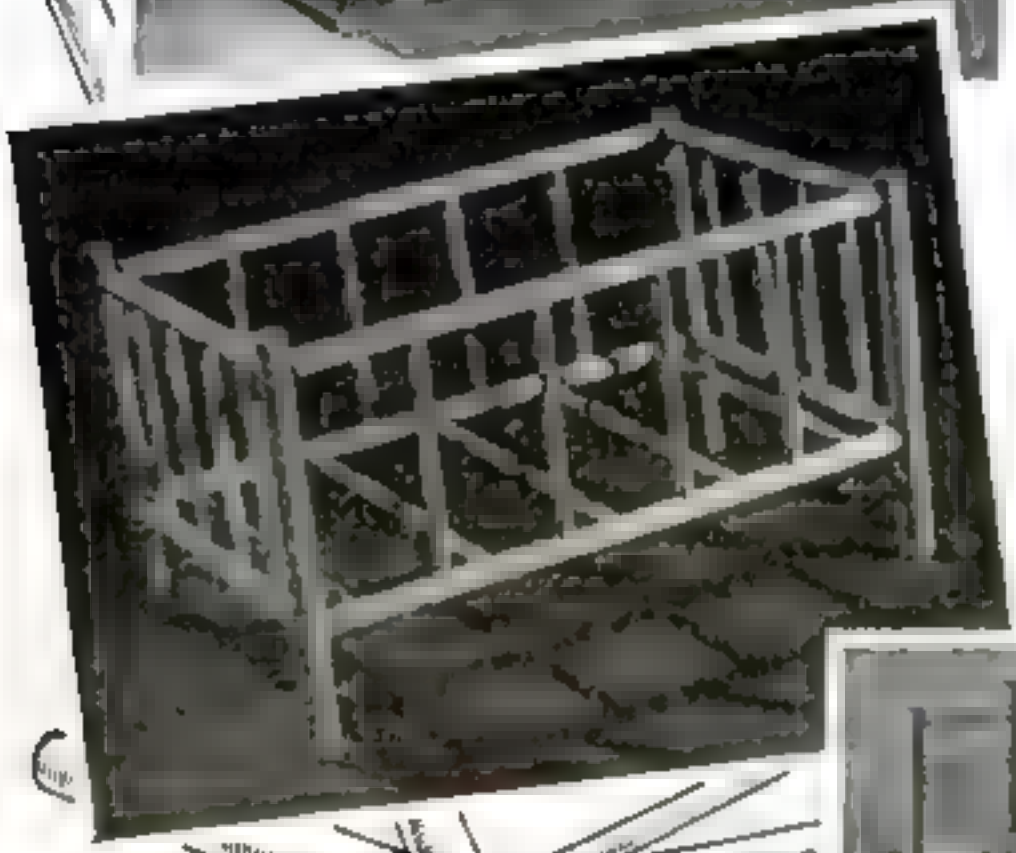
Fun for Those Who Make Things

RULES

Send entries, fully prepaid, to the Dowel Contest Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York 10, N. Y., to arrive on or before September 30, 1944.

Send as many pieces as you please, but all entries from any one person will be considered as a group and will be eligible for only one prize. Identify each piece with your name and address.

The judges will be the editors of POPULAR SCIENCE, and their decision will be final. Duplicate prizes will be awarded in case of ties.

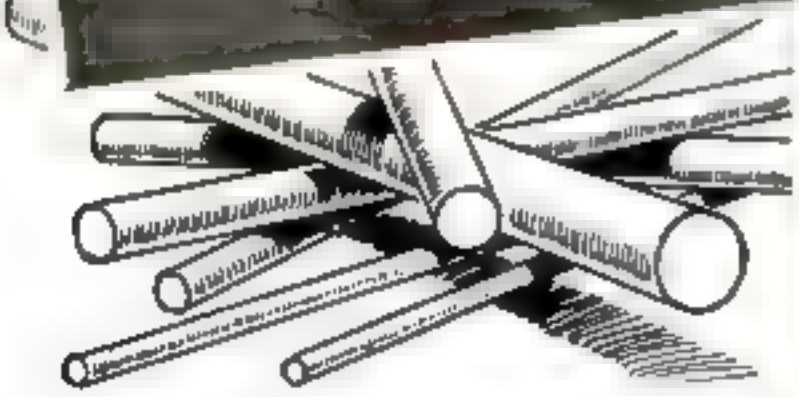


WHAT can you do with dowels? Can you build things with dowels as well as use them for joining pieces? Here's a chance for you to try your hand. See what you can build using nothing but dowels, or using just one piece of flat stock with them. Then enter it in our Dowelcraft Contest.

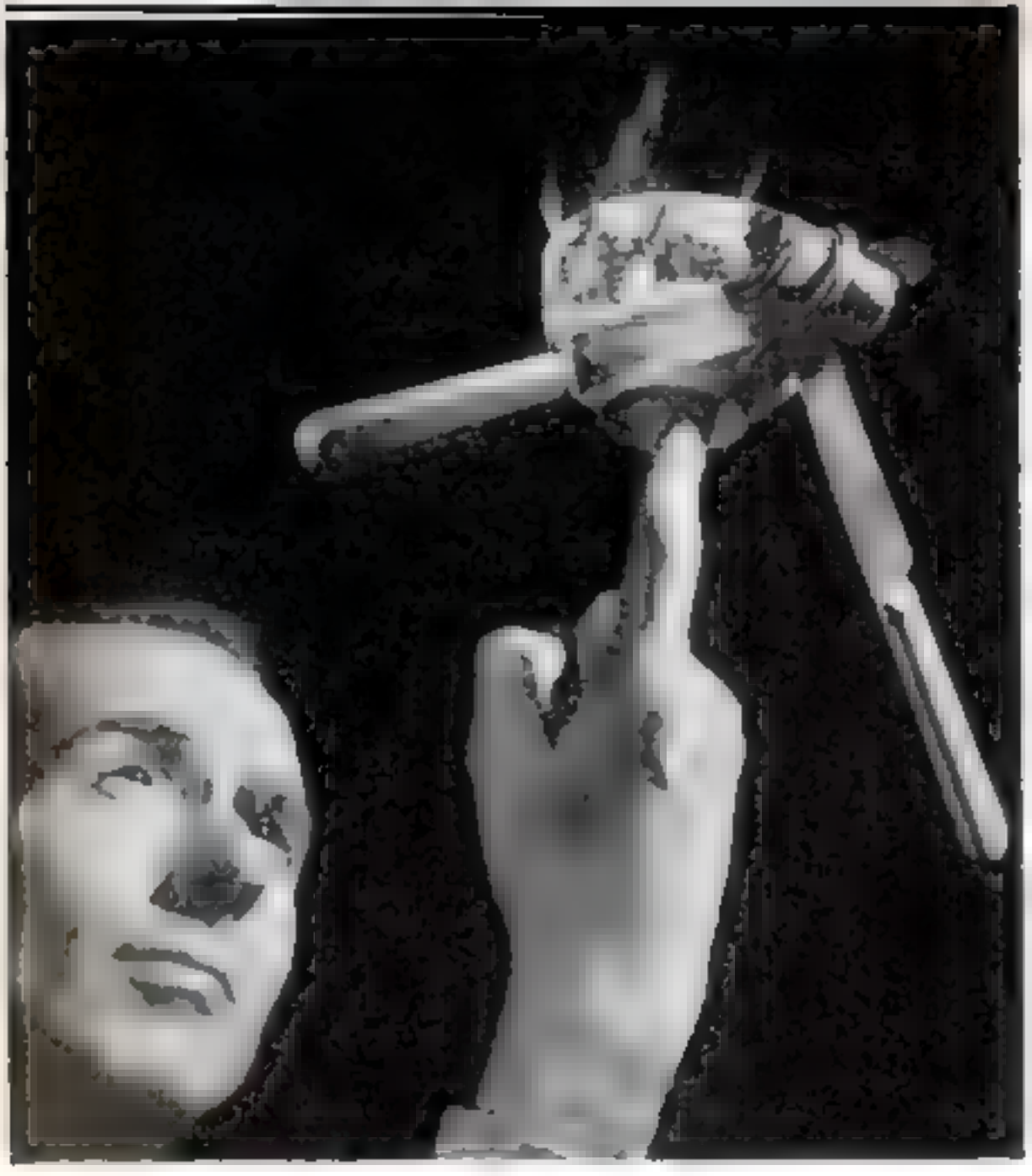
To make the competition more interesting POPULAR SCIENCE is offering $50 in cash prizes for the best eight entries. The awards will be made as follows:

First Prize	$25
Second Prize	$15
Third Prize	$ 5
Five Prizes	$1 each

Some of the things that can be made of dowels are shown in the accompanying photographs. But don't attempt to copy them, for ingenuity as well as skill in craftwork will count. There is no limit on what you can make—it can be useful, ornamental, or a toy. It should be kept small enough, though, to be mailed or expressed easily.



THEY'RE EASY IF YOU KNOW HOW!



BALANCING A CUP, two dinner knives and a strip of newspaper on the end of your index finger is easy if you know how to put them together. Let your friends try their version first, and after they have failed, show them how it's done.

Cross the two knives through the handle of the cup, as shown in the photo, and hold them in place with the piece of newspaper rolled up. This lowers the center of gravity and makes the cup stable—so stable, in fact, that you can even balance it when it is partly filled with coffee! But your friends had better try with an empty cup.

This and the other tricks illustrated on these pages will be found good for many after-dinner laughs.

FLOAT AN ICE CUBE in a dish of water and ask a friend to try to lift the cube with a light, looped string. The harder he tries, the more the ice cube will evade him. Then you can show him how it is done—scientifically!

The loop is provided merely to mislead. Lay either end of the string across the cube and sprinkle a little salt on top. This will cause the top surface to melt slightly. Then wet the top with some fresh water; in a moment the surface will freeze again, gripping the string firmly enough for lifting.

HOLDING UP a full glass of water with nothing but a piece of cardboard and a wire is a fascinating trick. Knot the end of a light wire, push it through a hole in the card, and seal the hole around the wire with wax. Now, if the glass is filled to the brim and the card makes perfect contact all around, no air will remain between the card and water, and air pressure beneath the glass will hold it to the card.

THIS SHELL GAME is played with matchboxes. All three boxes are empty, but one appears to rattle when you shake it. After demonstrating this, shuffle the boxes before your friends' eyes and let one try to pick the box holding a few matches. He will fail. A fourth box, in your sleeve, is the one that really rattles!

TABLE TRICKS

ANOTHER BALANCING STUNT is the one at the right—done with a nickel and a glass three-quarters full of water. You must use a buffalo nickel, one not worn too smooth, and turn the Indian face up on the table. Set the balancing edge carefully so it will be aligned with the line made by the Indian's forehead and nose. There is a slight trough there—sufficiently deep to steady the glass and hold it on edge.

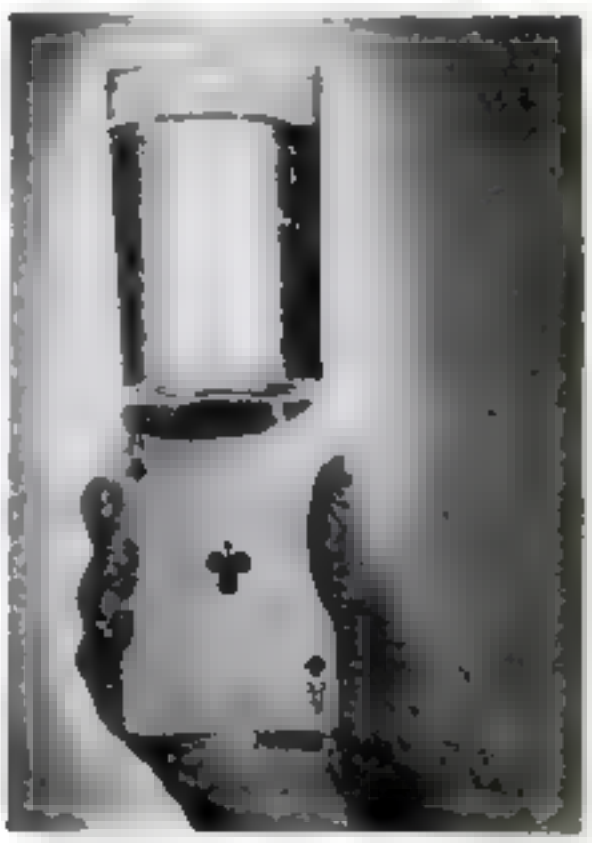
STANDING A MATCH ON END is simple enough when you once learn the trick, but your friends will fail every time unless they are let in on the secret. The very simplicity of the trick makes it all the more astonishing

When no one is looking, wet one of your fingers with saliva, and touch the match with this wet spot before you try to stand it up. Press the match down firmly on the table, and the saliva will hold it in place. Use an ordinary wooden match, either safety or kitchen type. Book paper matches won't do—they bend under pressure.

FLOATING CORKS UPRIGHT in a bowl of water involves a simple law of science. Put three ordinary corks in the bowl and invite your friends to stand them up. After all have had a turn and failed, wet the three corks thoroughly and group them together with their large ends down. They will be held in the huddle by the cohesion of water molecules and surface tension. Then, since the base formed by the three corks grouped together will be greater than their height, they will stand upright by themselves as long as they cling together.

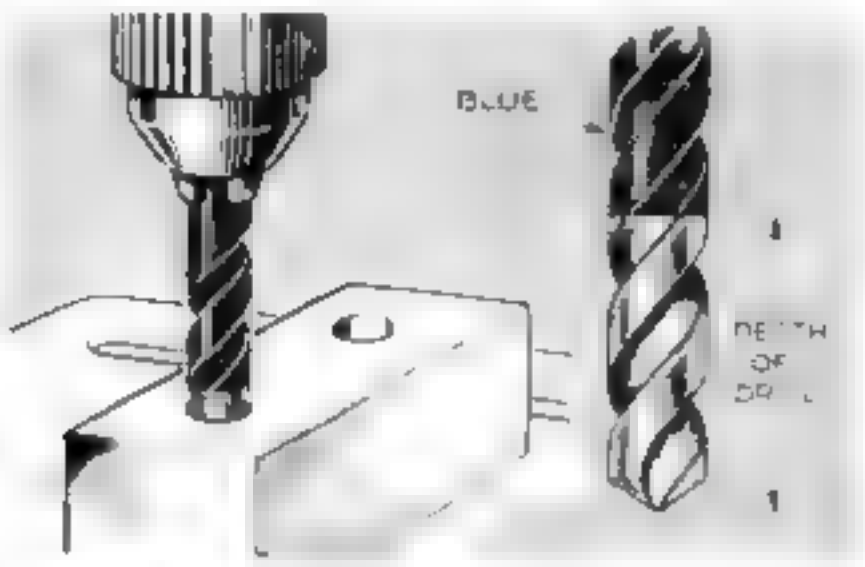
SEEDS WILL DANCE in a glass of ginger ale or other carbonated beverage. Drop several grape, apple, or lemon seeds into the glass. They sink and remain at the bottom until carbon dioxide bubbles become attached and buoy them up to the top. There, some of the bubbles break away, and the seeds sink again—only to repeat the performance while the bubbles last

ILLUSION is the secret of the balancing stunt shown below. To your friends, you appear to be balancing the glass of water on the edge of the card. Really, though, you have the glass off center on the card so that more of it extends at the back than at the front—and you hold the back on your upraised forefinger



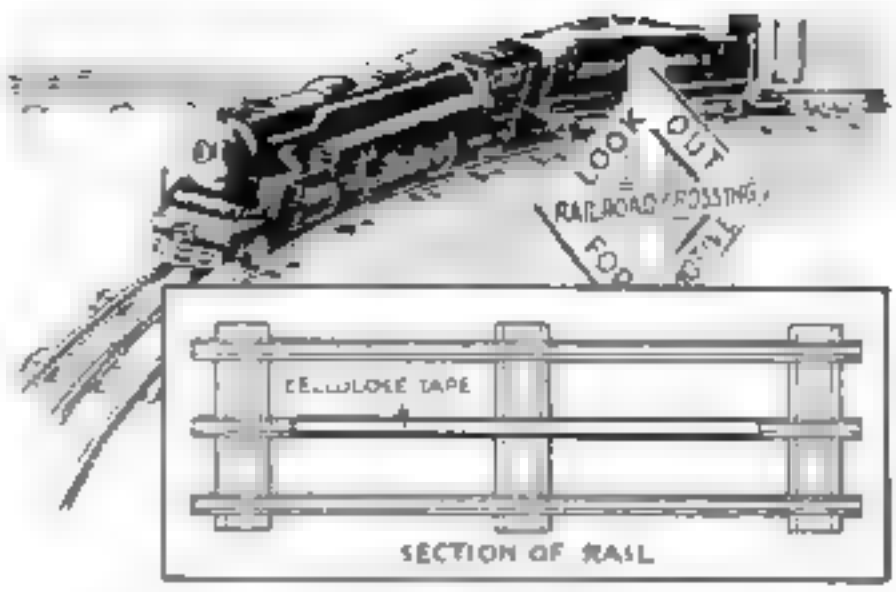
Visual Depth Gauge for Drill

WHEN drilling a series of equally deep holes, apply Prussian blue to the part of the drill that remains exposed. This substance, sometimes called marking dope, will not rub off, but it can be removed by swabbing with alcohol.—R. E.



Simple Vise Aids in Fly Tying

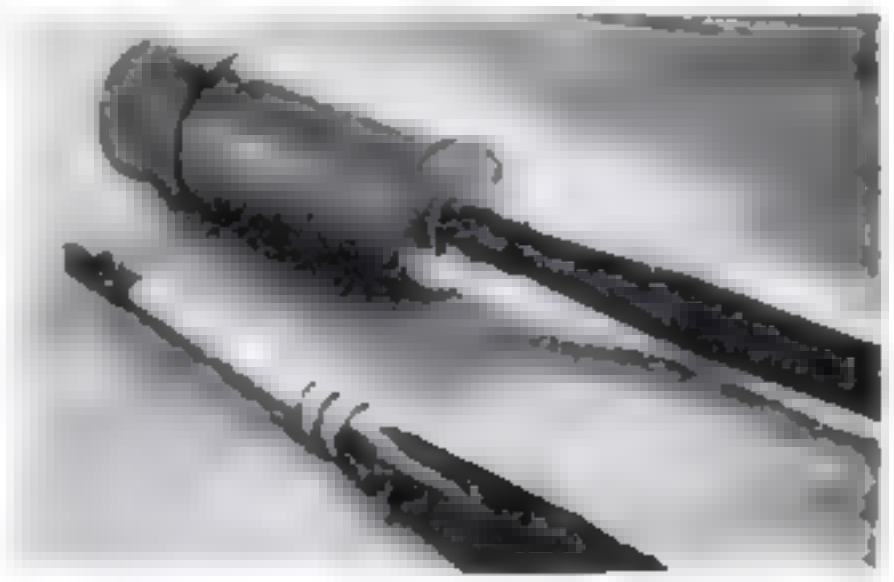
MAKE this fly-tying vise from a 7½" piece of ¼" drill rod. Round and smooth one end to form the head; then cut a 2" deep slot in it with a hacksaw. Drill a 13/64" hole through the middle of one of the jaws formed, and drill and tap the other jaw to take a 10-32 machine screw. For a handle, cut the head off a shingle nail and solder the shank into the slot in the screw head. The rod may then be bent to a convenient angle and mounted with a single 10-32 screw on your bench.—JOSEPH MESSER.



Model-Train Speed Controller

FULL speed on the straight run of an electric railway layout without danger of jumping the tracks on the curves is made possible by attaching a strip of cellulose tape to the power rail at the point on a curve where a reduction in speed is desired. This will insulate the power-pickup roller, causing the train to lose enough speed so that it remains on the rails.

The proper length of tape required for each curve, and its location, can best be determined by trial and error.—R. E.

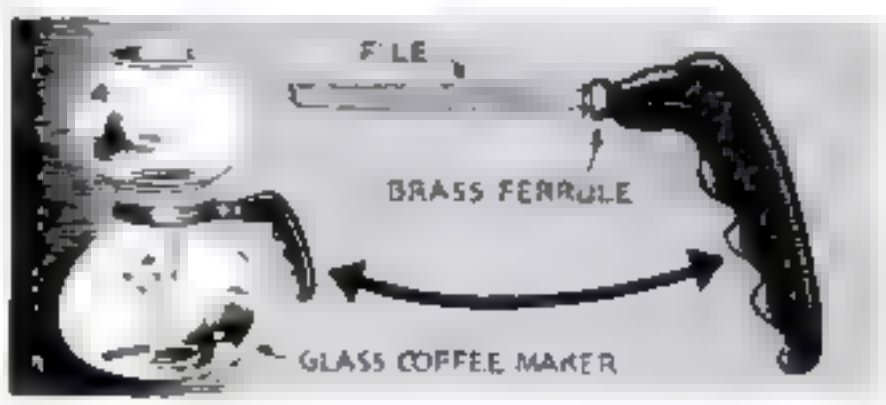


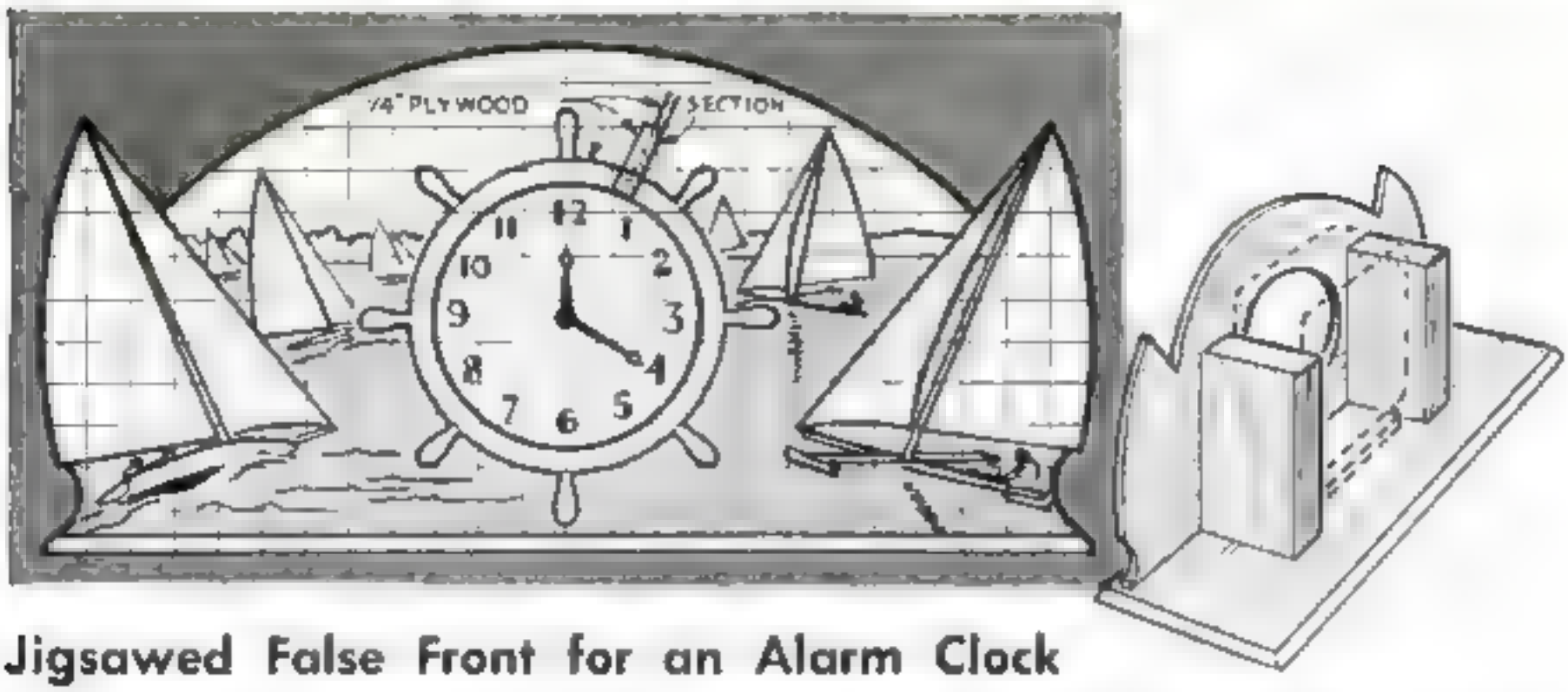
Tubes Protect Paintbrushes

ARTISTS' brushes will retain their fine points for a long time if the bristles are kept free from dust and out of contact with other articles. Small metal or cardboard containers are ideal for this purpose. In one end of each tube punch a hole just large enough to take the brush ferrule, as in the photo above.—H. A. KHARAS.

Old Glass Coffee-Maker Fitting Makes a Good File Handle

FOR more positive control over a file than is possible when using a regular file handle, use the curved handle from an old glass coffee maker. Drill a tightly-fitting hole in the butt end of the handle to take the tang of the file; then cut down the outside so that it is round in cross section and force over it a brass ferrule to prevent the tang from splitting the handle.—FRANCIS L. TYLER.

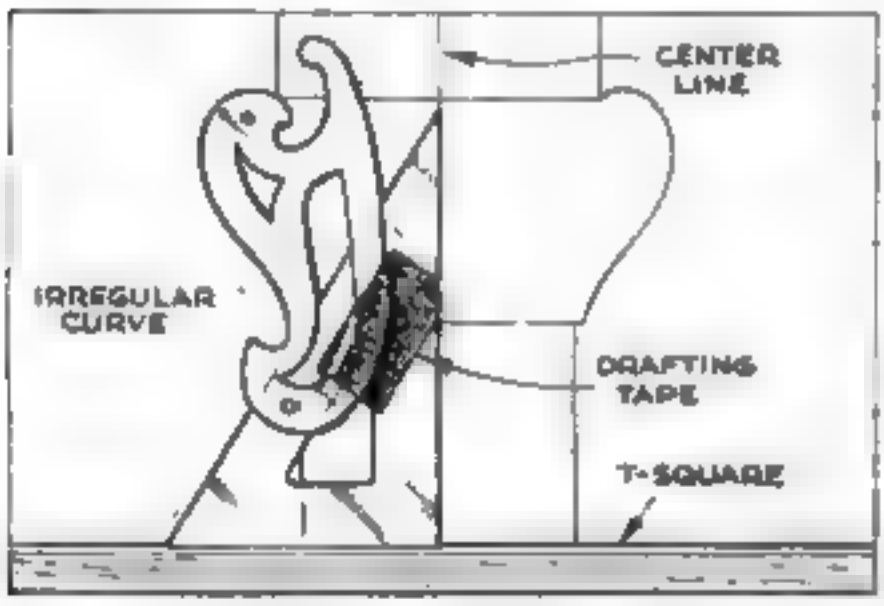




Jigsawed False Front for an Alarm Clock

BY ADDING this simple false front to an old alarm clock, you can transform it from an eyesore into a novel and ornamental piece for a boy's room, your study, or a vacation cabin. The stylized sailboat-and-iceboat design shown here is merely a suggestion. Almost any design that will allow you free expression on the jigsaw will be acceptable.

Cut the front from a piece of plywood and the base and two supporting blocks from ½" white pine. Make the opening in the front a little smaller than the size of the clock face. If the clock is rectangular, then the opening should also be rectangular. Space the blocks so the clock will fit snugly between them. Finish the front in enamel or lacquer, using bright colors to set off the component parts of the design.

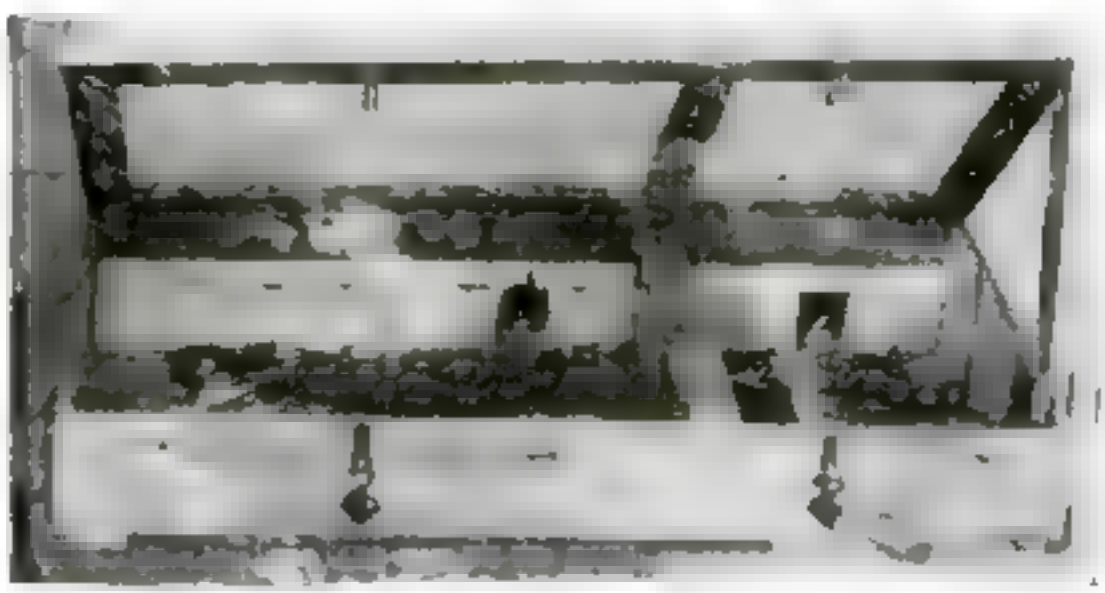


Drawing Aid Duplicates Curves

WHEN making a drawing of a symmetrical object, such as a column, try this drafting trick for duplicating curves on opposite sides of the figure. After drawing in the shape on one side completely, fasten a triangle, with its vertical edge lined up with the center line of the figure, to the curve with one or two pieces of drafting tape. To duplicate the shape, turn the triangle-and-curve assembly over and align the vertical edge of the triangle once more with the center line.—R. E.

Padlocked Outdoor Cage Keeps Reptiles out of Children's Reach

KEEPING poisonous or otherwise dangerous reptiles on the same property with children might lead to an unfortunate accident. This cage is so situated and so constructed that there is no chance of young children coming in contact with the reptiles. The partitioned section, shown at the right, has a wire-mesh lid that is hinged and double-padlocked. This box extends from the side of the building at a height sufficient to prevent children from tampering with it. Two ventilated boxes are attached to the inside wall at the same height as the outside box. These have solid doors, which are also padlocked. Openings between the inside and outside boxes allow the creatures to crawl back and forth. The illustrated cage was built by Keith Boyd, of Los Angeles.—WELDON D. WOODSON.



What You Can Do with a Miter Box

By EDWIN M. LOVE

NOTHING more than a jig for a handsaw, a miter box is used for cross-cutting moldings and narrow boards. In its simplest form it is a wooden channel having kerfs in the sides to guide the saw in squaring or mitering the stock. Commercial boxes range in design from modifications of the simple wooden type to precision tools built of steel and adjustable for exact sawing at many angles and for various depths.

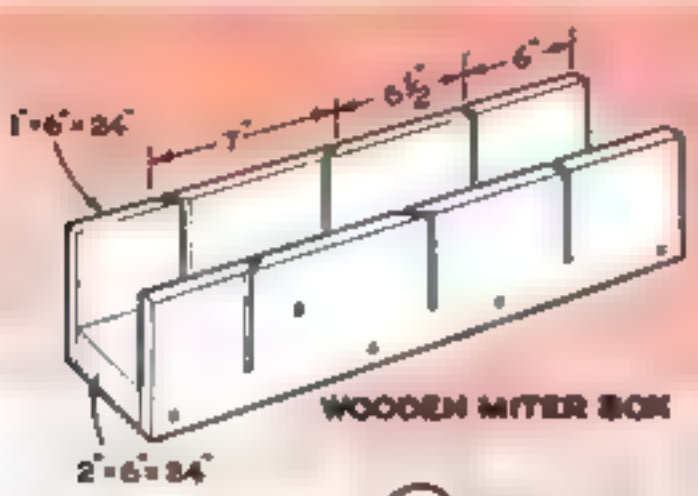
How is a wooden miter box made? It depends on the use to which the box is to be put. One for cutting and mitering narrow strips, such as sash and trim for screens, can be made simply by nailing together two pieces of scrap wood to form a small angle. One piece of the stock serves as the base, and the other is kerfed to guide the saw. For more accurate mitering, a third piece of stock can be added to form a second side, and the kerf in the first side can be matched in the second to hold the saw straight. Carpenters often make a box for larger stock by using a piece of 2" by 6" material for the base, as shown in a drawing. The sides must be square with the base and the kerfs accurately cut or the pieces being sawed will not turn out as desired.

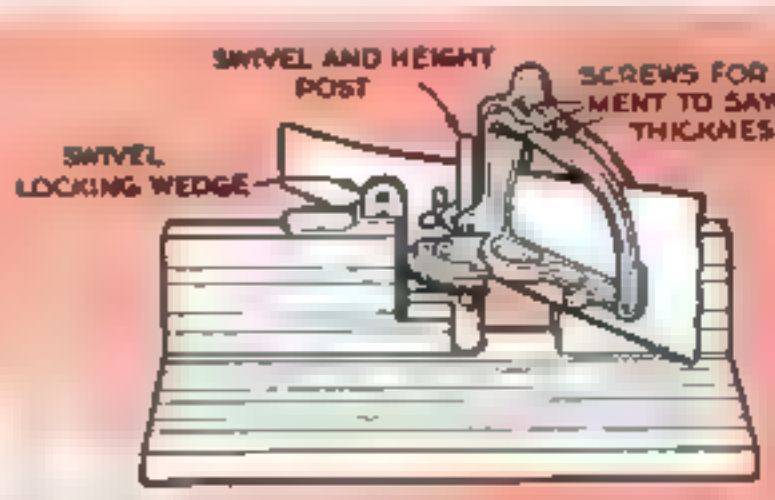
What is the best way to use a miter box? Rest a wooden miter box on bench hooks, tack it to a rough bench or sawhorse, or clamp it in a vise. Brush out all sawdust and chips and make sure that the piece to be cut is flat against the back and base. To keep molding from slipping forward in the box, especially wide molding, lower the handle of the saw during the first part of the cut, and then level the teeth as the cut nears completion.

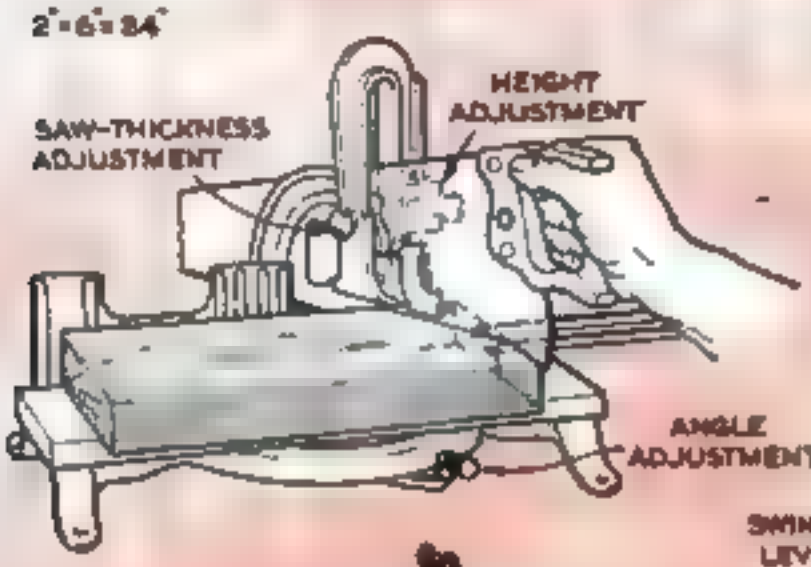
Molding joints for door and window trim will not always fit, even if accurate cuts are made. This is because the settling of old houses is often uneven and causes the door and window frames to move out of square. To correct for this when fitting new trim with butt joints, place a thin cardboard or wooden shim between the back edge of the trim and the miter box near the cut, thus

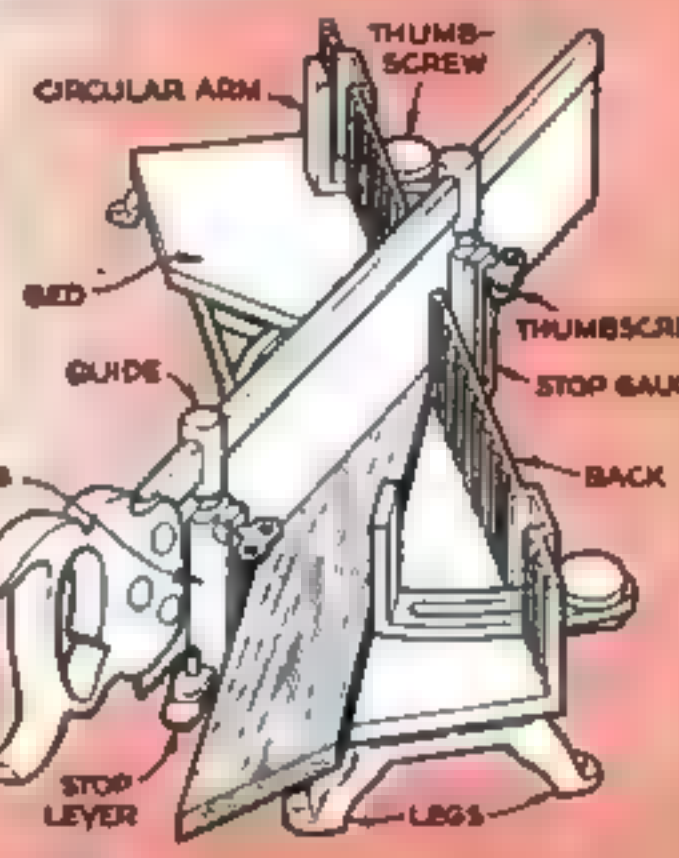
modifying the 90-deg. cut to match the amount the frame is out of plumb. If the trim is mitered molding, the shim should be placed behind the edge of the side and head casings near the cut for one side of the frame and at the other end of the miter box for the other. The thickness should be sufficient to incline the molding half the amount of the lean of the frame; then, since both mating mitered casings will be corrected, the final result will match the frame.

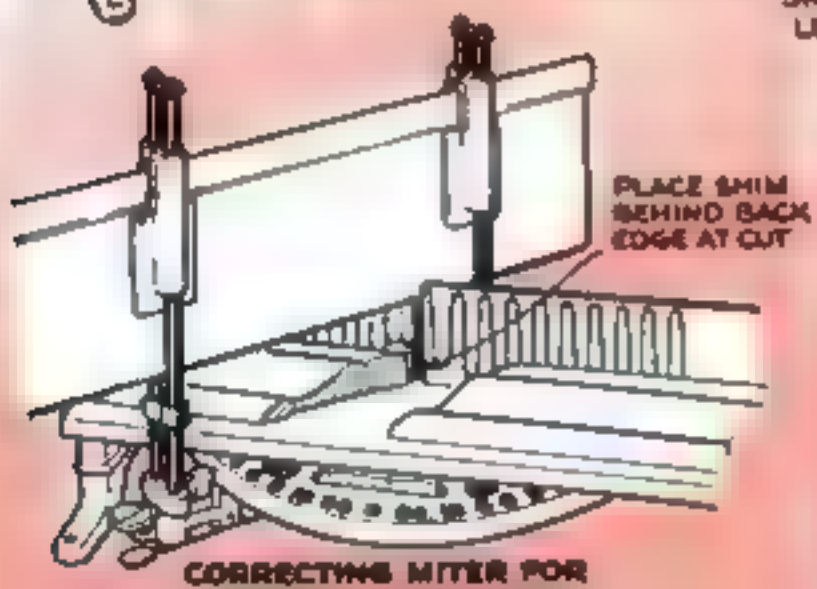
Another condition may prevail with the plaster projecting beyond the edge of the jamb, holding the outer edge of the casing forward in a shallow hopper effect. To correct for this, place a shim under the rear edge of the molding in the miter box, simply holding it in the position it will occupy



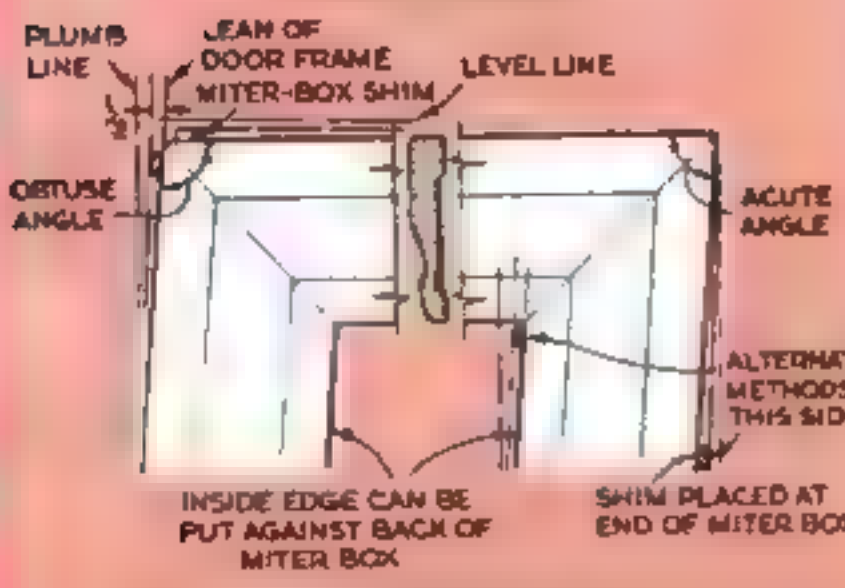




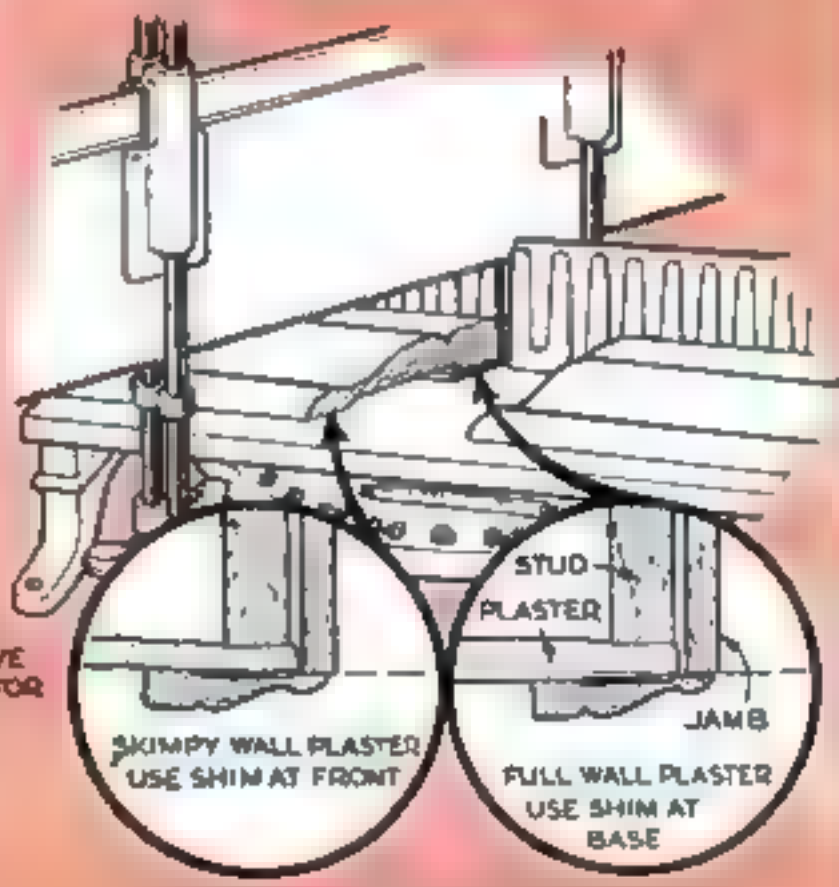




CORRECTING MITER FOR OUT-OF-PLUMB CASING: OBTUSE CORNER



OUT-OF-TRUE DOOR TRIM



CORRECTING FOR HOPPER EFFECTS ON DOOR TRIM

when nailed in place. When plaster is skimpy, a shim under the forward or inner edge in the box will make a correction that will allow for the piece to be nailed back sufficiently at the outer edge. Several such corrections are shown in the drawings.

Can a miter box be used for partial cuts? The back of a wooden box makes it hard to judge depth of cut, but a strip of the right thickness placed behind the work will show when the saw has reached the depth at the back. The position of the saw can usually be seen at the front so that the depth of cut can be judged there by eye. Handle the saw the same way you would for an ordinary cut of full depth.

What is the advantage of a metal box? The set of the saw teeth wears the kerf rapidly in a wooden box, widening it and making it inaccurate in time, whereas the kerf in a metal box always remains the same, assuring accurate cuts with such a box for its entire lifetime.

How is a steel box used? Set it firmly on the bench. Carpenters often nail a steel miter box to a rough plank bench or mount it more or less permanently on a sawhorse. The use of bolts and wing nuts with holes bored through a sawhorse will provide a quick method of attaching and detaching a miter box. Another satisfactory method is to stand the box on bench hooks, as shown in one of the photos, in which case the left hand should be used to keep it from working forward.

Insert the saw in the guides, being careful not to damage the teeth by contact with the metal. On some boxes the guides will lock if drawn to the top, and in that position they hold the saw out of the way while the stock is being inserted for sawing. Shaking the saw handle or tapping the guides permits the saw to descend when you are ready to use it.

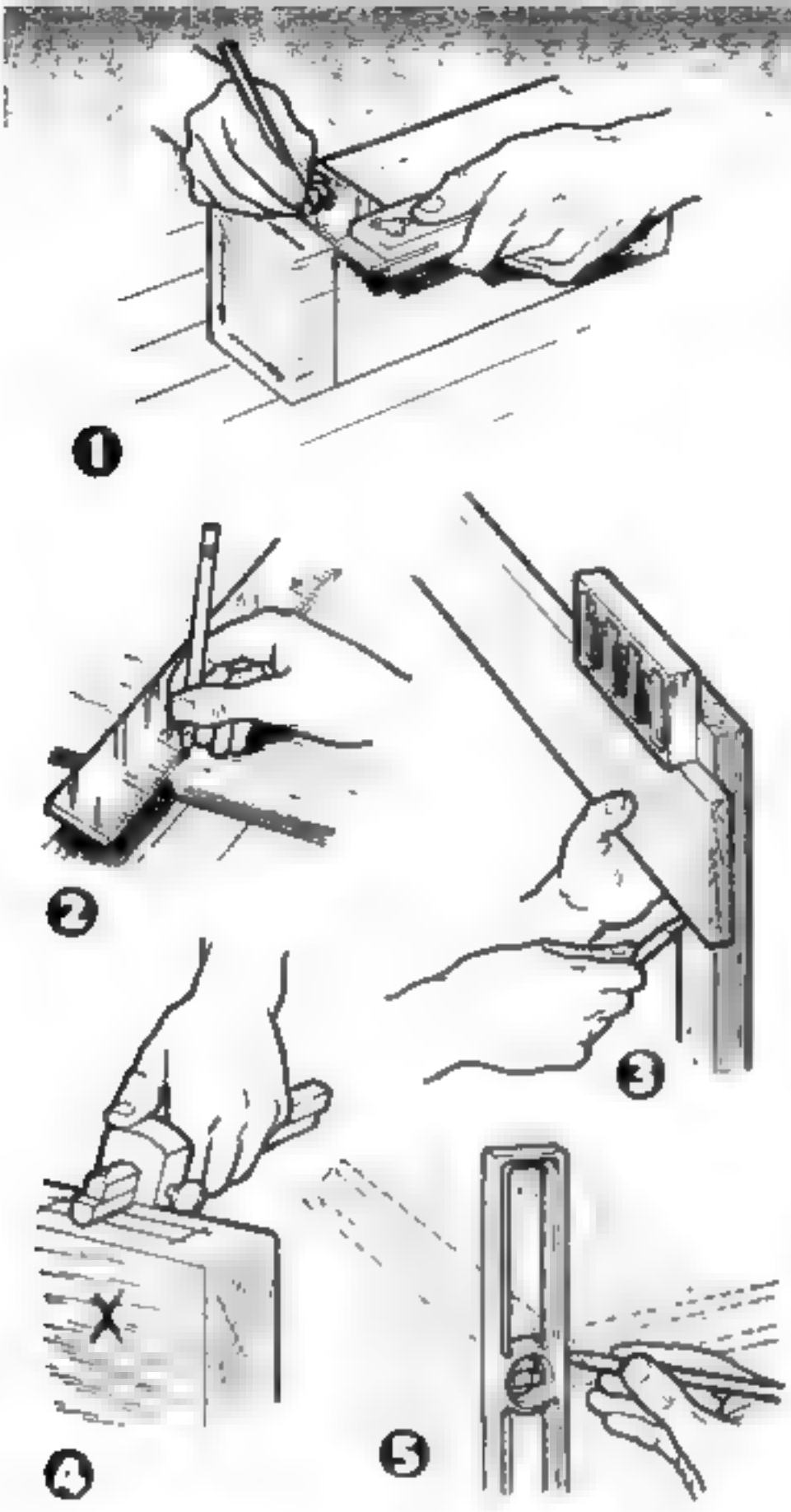
What adjustments are possible? Adjustment of the sawing angle is made by releasing a catch at the front of the miter-box swivel arm and then swinging the arm to the desired notch or degree mark engraved on the quadrant. There is a clamping arrangement on some swivel arms for settings at intermediate positions or for adjusting the saw to cut along a line drawn on the work.

Depth of cut can be limited by adjustment of the depth gauges if the saw used is a backsaw. Even without adjustment of the depth gauges, the saw on a steel box cannot scrape the bottom and damage its teeth after cutting through a board. You should remember, however, that the stroke of the saw is limited, and avoid withdrawing the end from the rear guide.

Are accessories available? Among accessories for some steel miter boxes is a useful segment arm that is pulled out from the back to swing the work out for cutting angles of less than 45 deg. Built-in length gauges simplify duplicate sawing, although a block nailed or clamped to the bench will often serve. An adjustable homemade length gauge is described on the facing page.

In making a miter box, nail the front and back on square with the base and be sure their tops are level; then lay out kerf lines with the aid of a square and knife. For 45-deg. kerfs, line up the same inch mark on both legs of a framing square with one side of the box, as shown above. When using the box, hold the work against the back, as at right. The stop block clamped on the box in the photo permits duplicate sawing

What's Wrong?



CAN you find six errors in woodworking shown in the five drawings at the left? 1. Guide lines to square the ends of a piece of 4" by 4" stock are being drawn with a try square held against successive sides. 2. An attempt is being made to locate a point accurately on a board. 3. Leveling is being done from stake to stake preparatory to building foundation forms for a house. 4. The sides of a mortise are being gauged on a door stile. 5. With guide lines drawn for nailing a molding parallel to the floor and a ramp, a line is being plumbed on the wall for use as a guide in cutting the joint. After you have jotted down your answers, turn the page upside down to compare them with the correct ones given below.

ANSWERS. 1. Unless opposite sides are exactly parallel, the lines will not meet at the last corner. Two adjacent faces should be marked and the other two squared from them.

2. Accuracy cannot be obtained with a blunt, soft pencil; a sharp, hard pencil or, better still, a knife is needed. A second error occurs in laying the scale flat. It should be held on edge to bring the graduations into contact with the work.

3. The level should be placed at the center of the straightedge where it would parallel a line drawn through the ends even if the straightedge sagged.

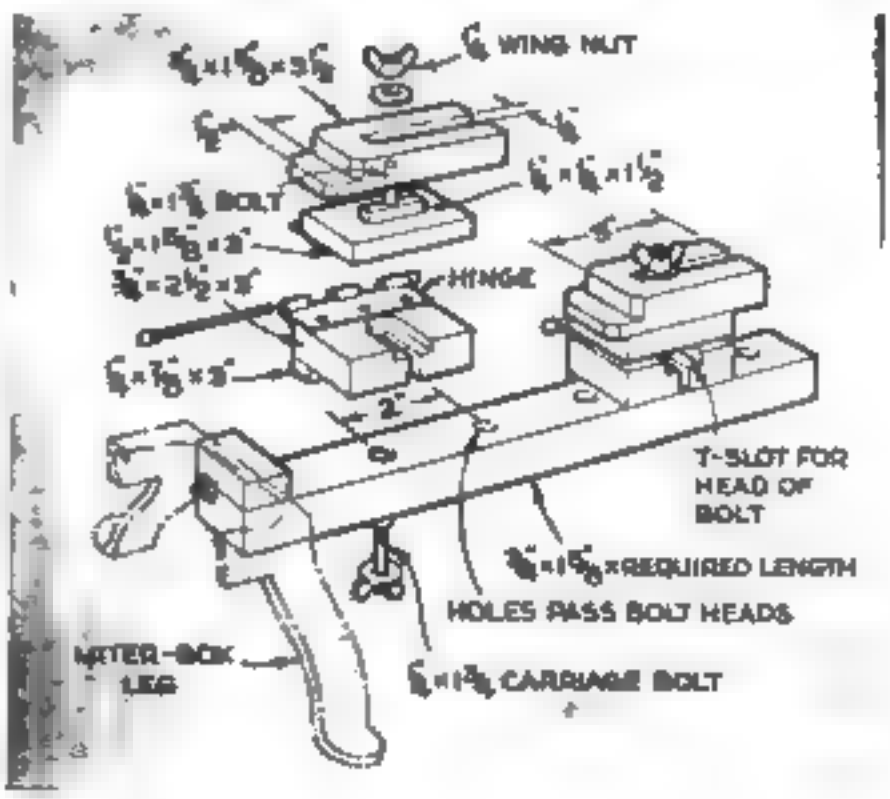
4. For assurance that the front faces of the joining members will be flush, press the gauge head against the working face (marked X) of both stile and rail.

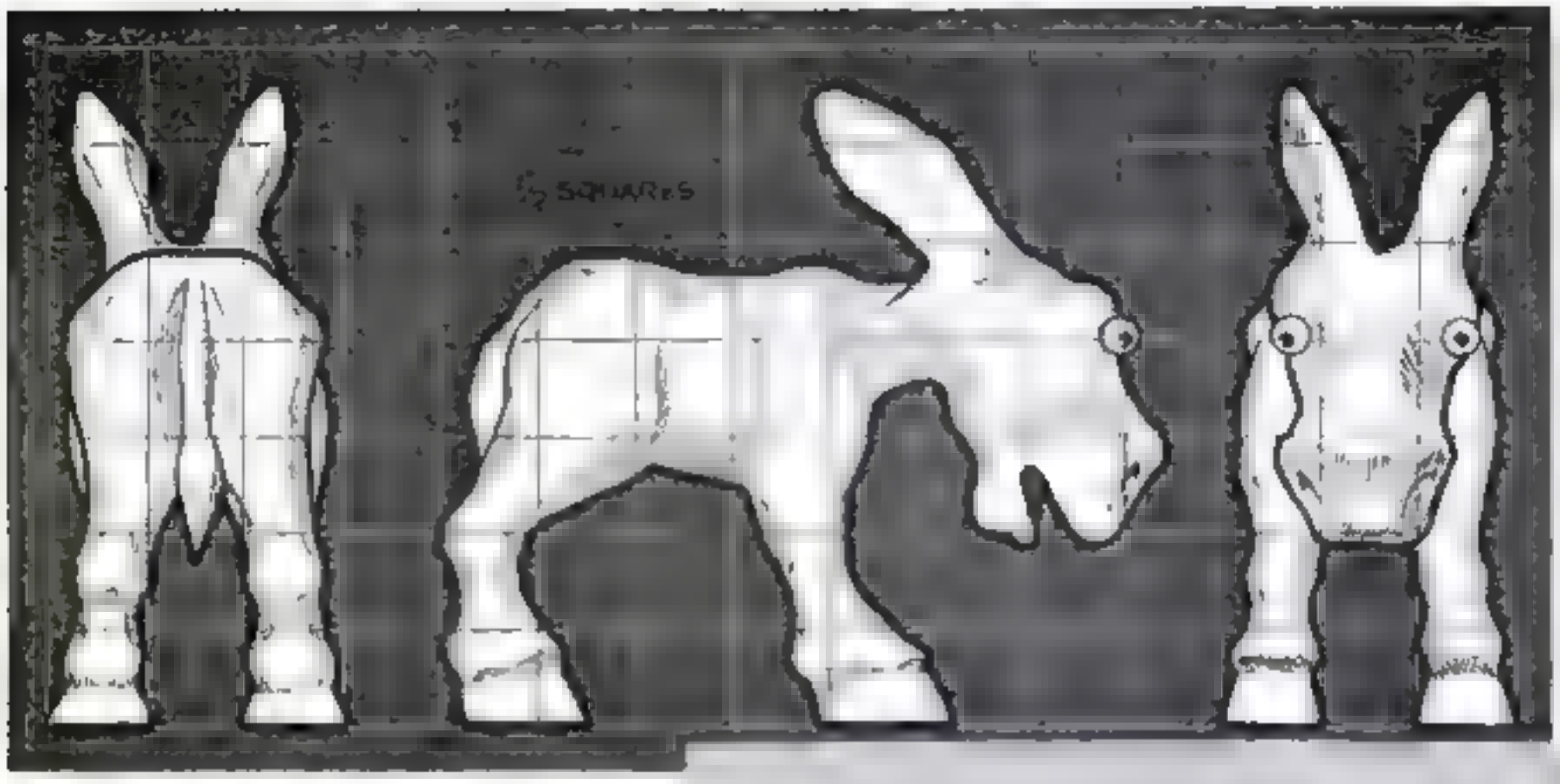
5. Both moldings must be cut to the same angle or they will not match at the joint. Bisect the angle they make with each other to obtain the joint angle.

Adjustable Length Gauge Is Bolted on End of Miter Box

MAKE the bar of this miter-box gauge any desired length and attach it to the end of a steel box with a bolt passed through a drilled hole. A block will support the far end. If a wooden box is used, fit it with blocks for feet and extend the bar under the base where it can be screwed on. To set a stop, pass the lower carriage-bolt head through the bar and engage it with the T-slot in the base of the stop block, locking it with the wing nut. Then slip the stepped stop into place, slide it to the exact position, and tighten its wing nut.

The hinged top of the stop blocks can be thrown back out of the way to permit several cuts in a piece of stock, such as those in sawing dadoes, to be duplicated quickly in other pieces.—E. M. L.





DIOGENES THE DONKEY

Fun for Whittling Fans

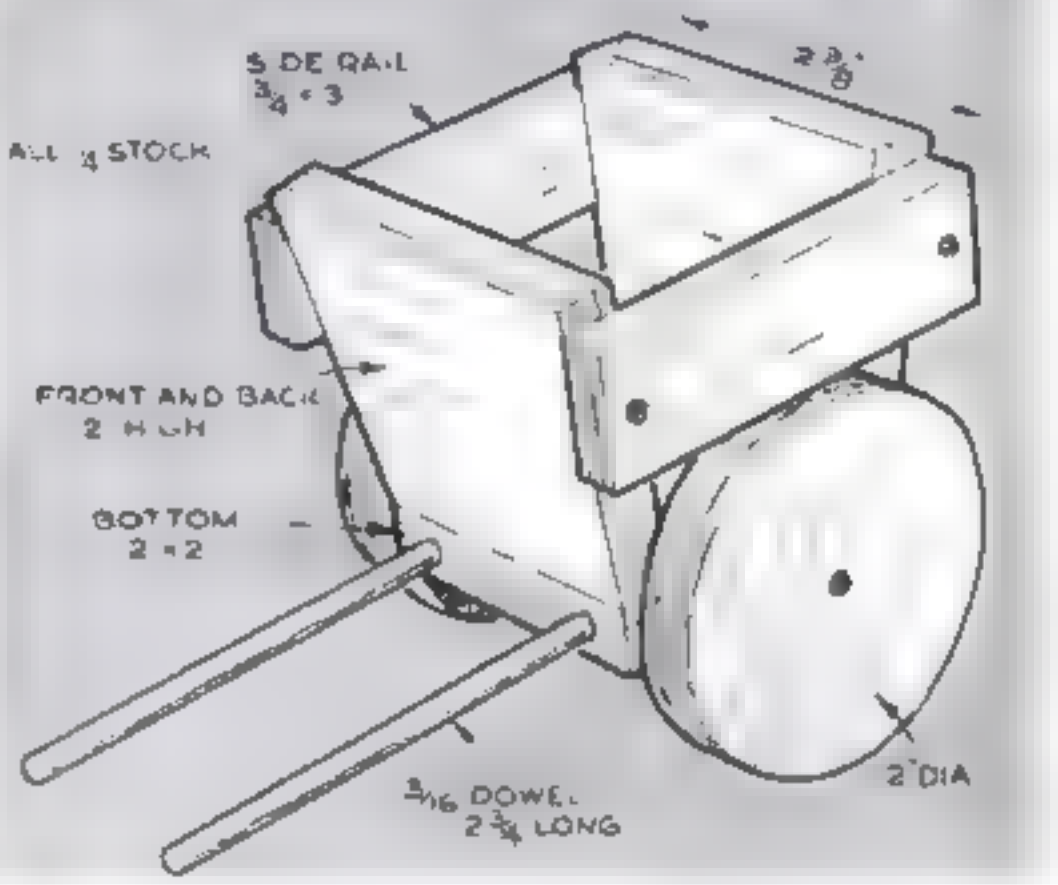
DISPLAYING disgruntled dignity, Diogenes the Donkey is an interesting jackknife project. His cart makes a fine plant holder

Transfer his side view to a 1½" by 8½" by 4" block of soft, close-grained wood. Saw this out; then drill a series of holes between each pair of legs and between the ears. This is to make the removal of the surplus wood at these spots a comparatively easy matter

Using a sharp knife and turning the work often, rough out the entire piece. Do not attempt fine details: Diogenes has more character and expression if elaborate finish is eliminated. Merely sand him down lightly; then apply a coat of varnish.

The eyes are white map tacks with pupils painted on in black, the hoofs are black, and the inside of the mouth and the nostrils is flaming red.

Make the cart of ¼" plywood. The axles are nails, driven through the wheel centers into the cart bottom. The shafts are glued into holes in the front of the cart and are fastened to Diogenes with small nails. Finish the cart with paint or shellac for any desired color scheme.—ELMA WALTNER.



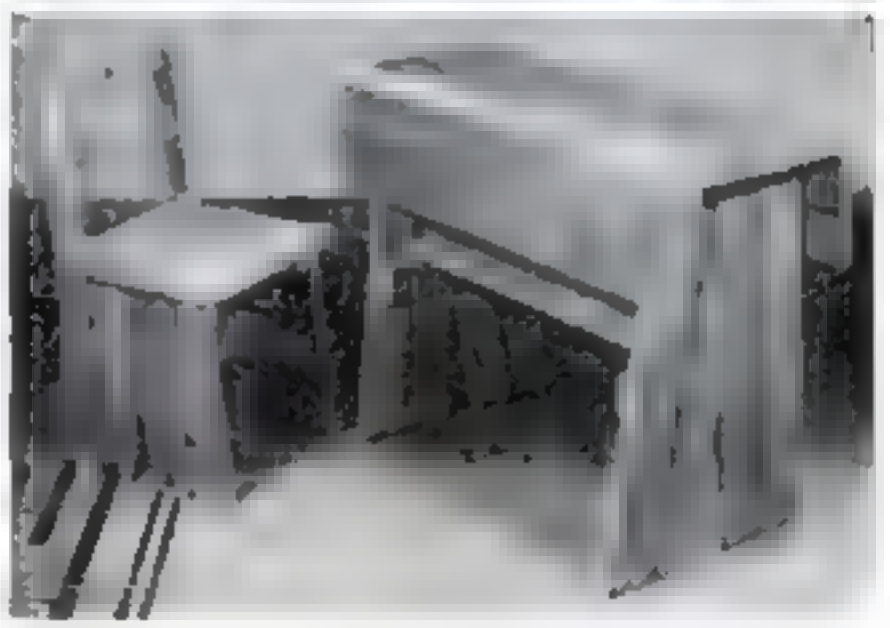
Although any type of plant may be displayed in Diogenes' cart, a tiny clay pot holding a cargo of cactus is ideal

Furniture for Little Folk

DESIGNED for children up to 10 years old, these pieces are made from fir flooring of standard width. All tongues and grooves on exposed edges are planed off. For each pair of chair and table legs, cut four pieces of flooring. Extend the back piece on each pair of chair legs up as posts to take two back slats. Fasten ¾" by 2" cleats to each set. Install a ¾" by 6" stretcher between the pairs of legs, resting it on the lower cleats. Use ¾" hardwood for the chair seat.

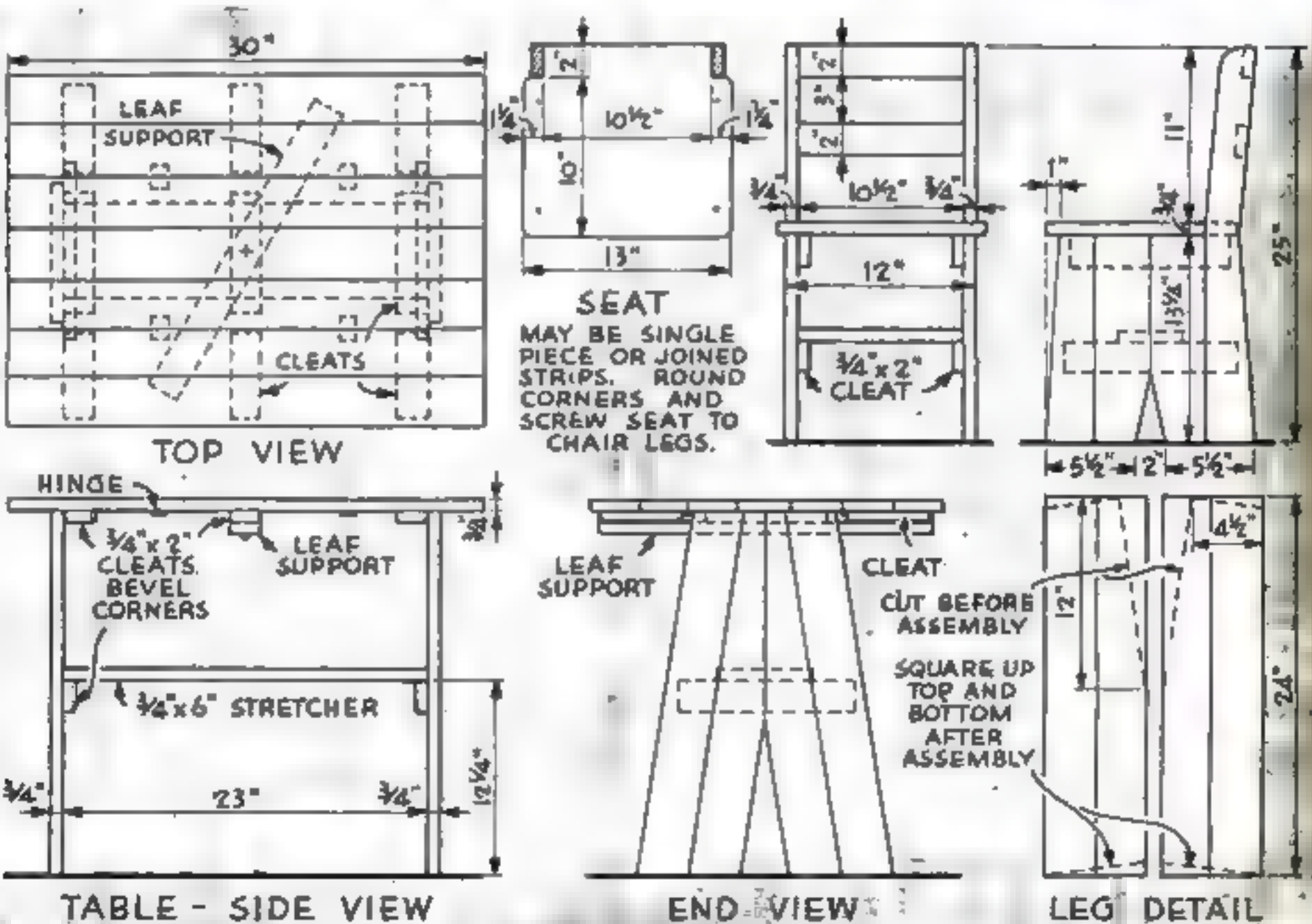
Make the table top in three sections: a stationary center part and two hinged drop leaves. For the center section, use three lengths of flooring, and for each leaf, use two lengths. Cleat each section on its underside, leaving room so the cleats on the drop leaves will not bind when the leaves are lowered. The leaf support is ¾" by 2" hardwood, pivoted on a screw run through its center into the middle cleat of the top.

The peasant design is painted in bright colors over a base coat of varnish. A second coat of varnish over the design fixes and protects the paint. Keep pieces well waxed to preserve the design.—E. W.



Kiddies will love this peasant chair and table set of simple design, construction, and decoration

All necessary dimensions, except the width of the table top, which is fixed by the size of material used, will be found in the drawings shown below

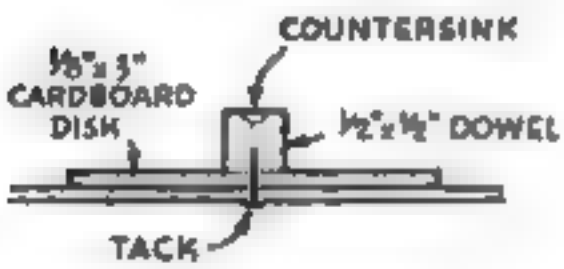


Spin-a-Hoop Game

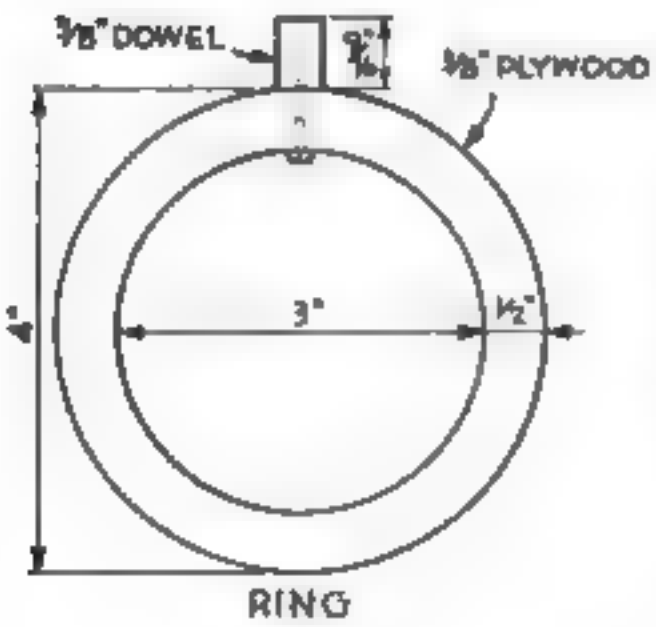
By
Myron Fleishman

SIMPLE and handsome in appearance, this new game is easy to build and easy to play. Draw a straight line from each upper corner of the ⅛" cardboard playing surface to its opposite lower corner. The point of intersection of these two lines is the center of the surface. Using this center, scribe two circles, one 3" in diameter and the other 10½" in diameter. Draw a vertical line and a horizontal line through the center. At the eight points where these lines and the two diagonals intersect the larger circle, tack cardboard disks and countersunk pegs. Add fencing around the edge. Assemble the playing ring as shown. Finish in poster colors.

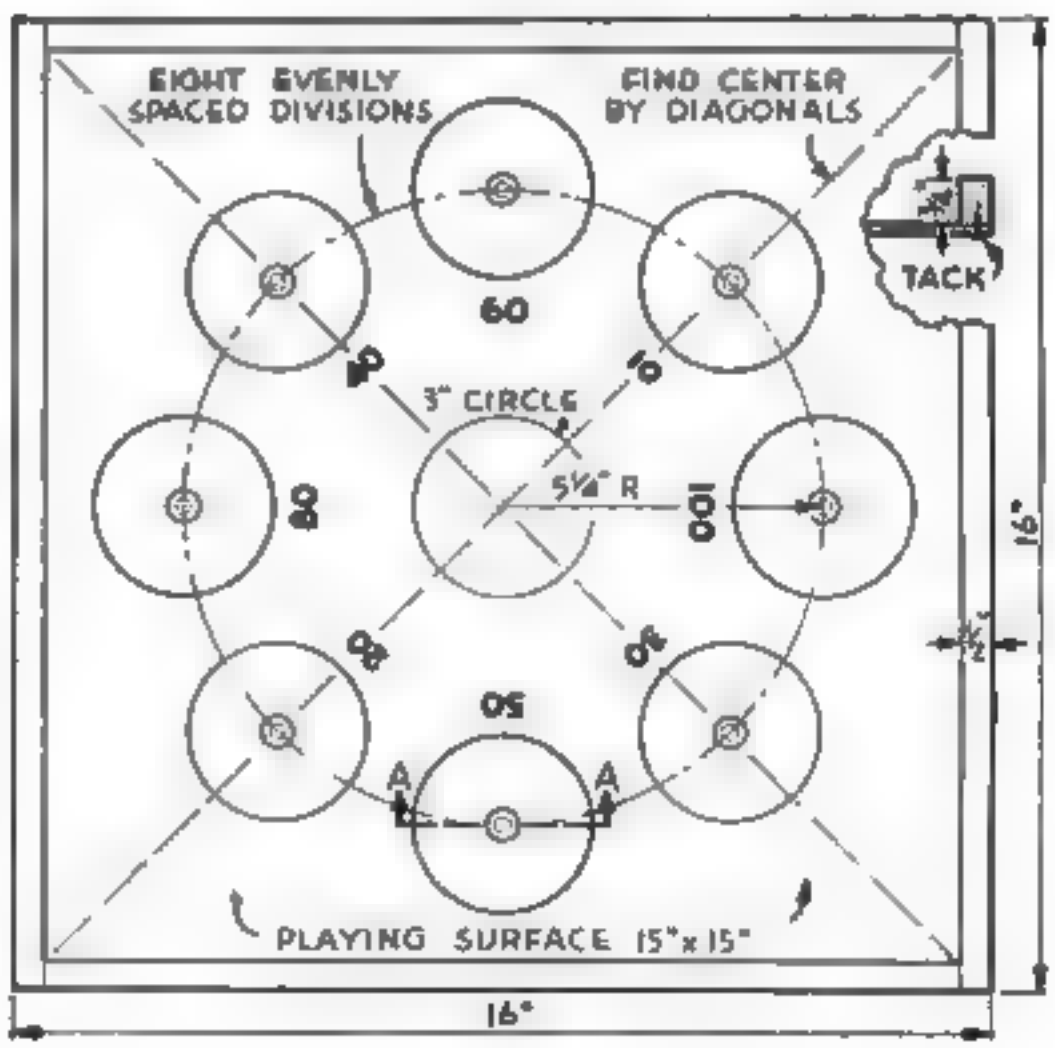
To play, place a ⅞" marble on each of the countersunk pegs. Grasp the playing ring by its knob, hold it in the center circle, and spin it. For each peg from which a marble is knocked, credit yourself with the amount shown. If the ring falls over a peg, double your score for that peg. Each player spins three times. Highest score wins!



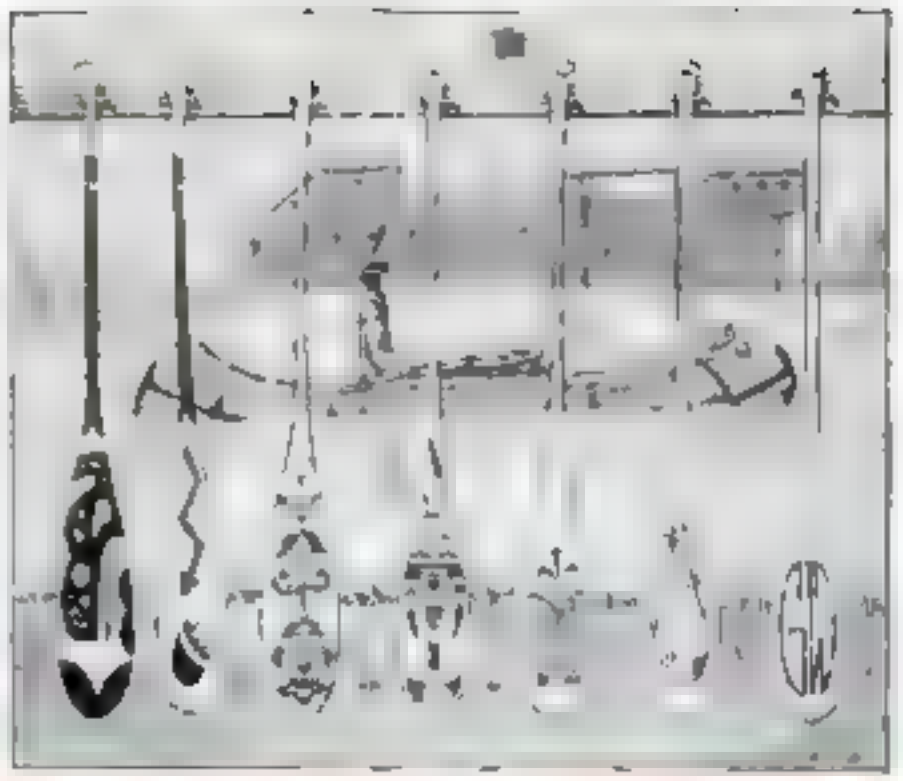
SECTION "A-A"



RING



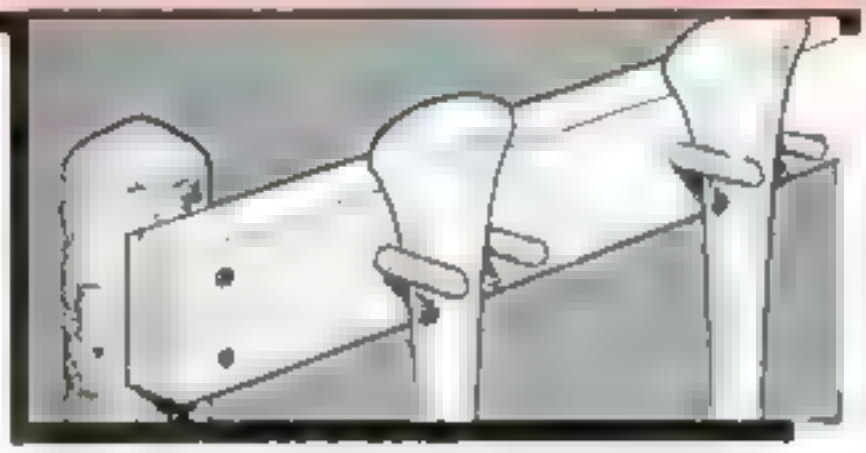
Decorations Add Individuality to Canoeists' Paddle Blades



DESIGNS applied to canoe paddles with marine paint are attractive and prevent disputes over their ownership. A few suggested decorations are illustrated below. From left to right: the first, done in red and black, is the Northwest Coast Indian tribe's stylized conception of a whale; the second is a floral design, taken from the Chippewas; the third, an owl, indicates wisdom; the fourth, a fish, is obviously closely related to water activities; the fifth, a thunderbird done in red and yellow, is the Indian's sacred bearer of happiness; and the sixth, a red lightning arrow and a dark-blue bear paw, means speed and strength.

Your monogram, or that of your camp, may be applied in red, green, blue, or black to the reverse side of each paddle.

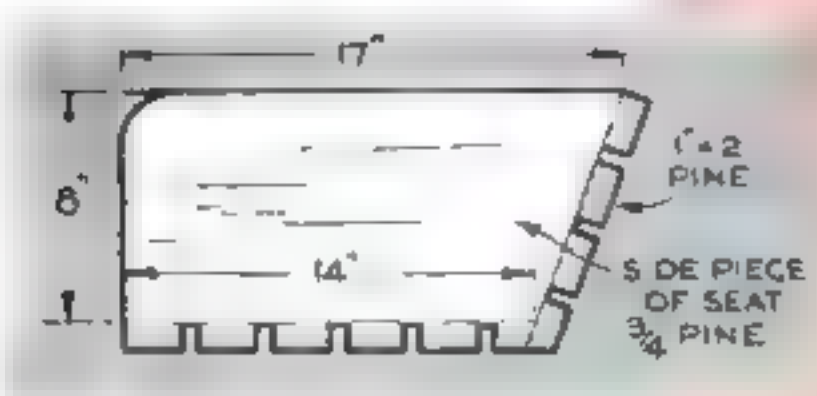
The paddle rack shown at the right is made by setting short lengths of branches into a piece of two-by-four, and nailing the plank to two upright poles.—GRAY WOLF

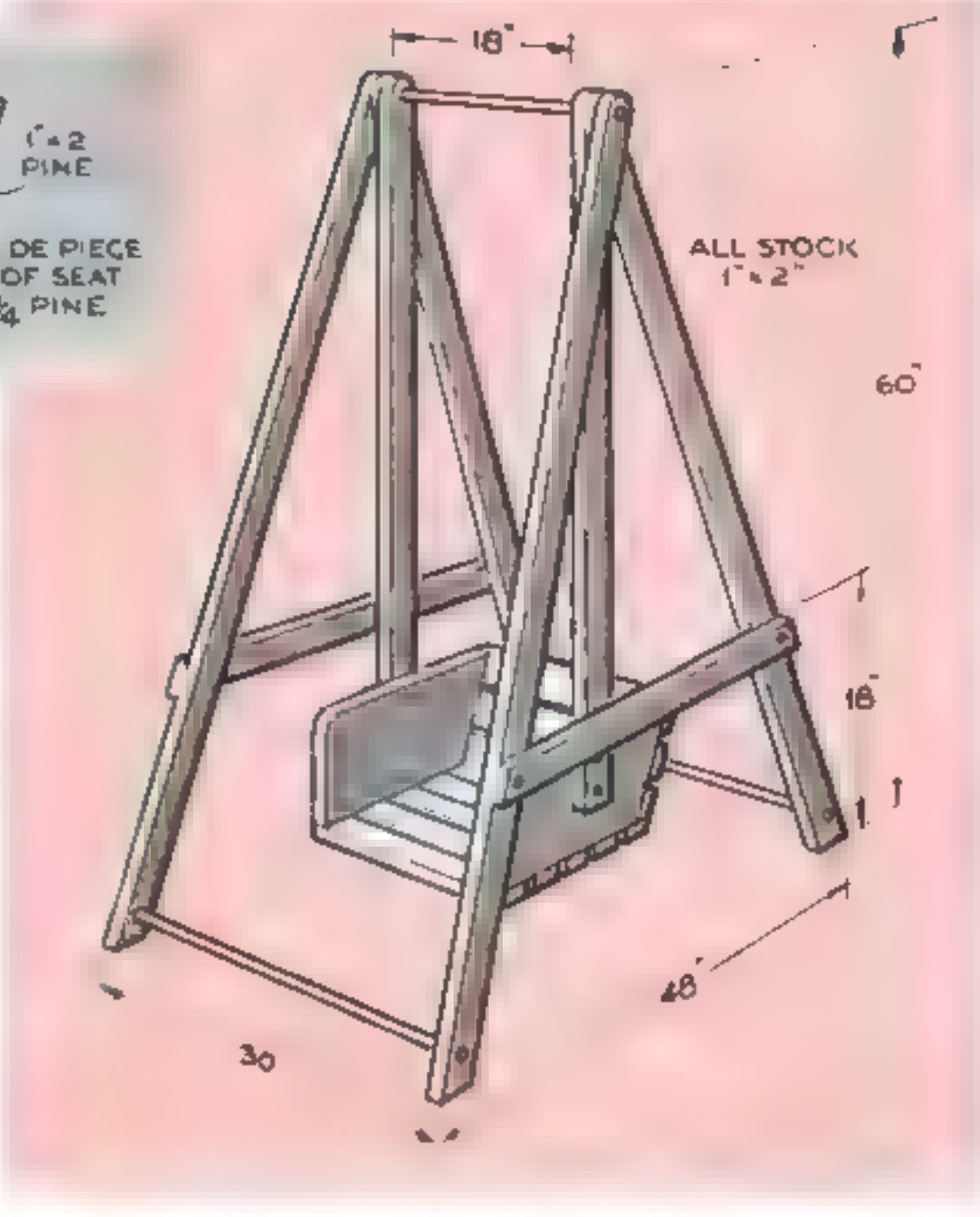


Candle for Campers Is Self-Timing and Self-Extinguishing

ONE of the greatest dangers in the forest is that of fire. The more obvious potential sources of conflagration include the candle used for lighting purposes. Too often such a candle will be left lighted and free to burn down to its holder while the camper wanders off or falls asleep. Besides being dangerous, such a habit is wasteful. It may be overcome by setting the candle in the partially open top of a used tin can, as shown at the left. When so mounted, it will burn only to the bent-up can cover. Upon reaching this point, it will slide down into the can and, in a moment or so, will go out.—C. BARTEL.

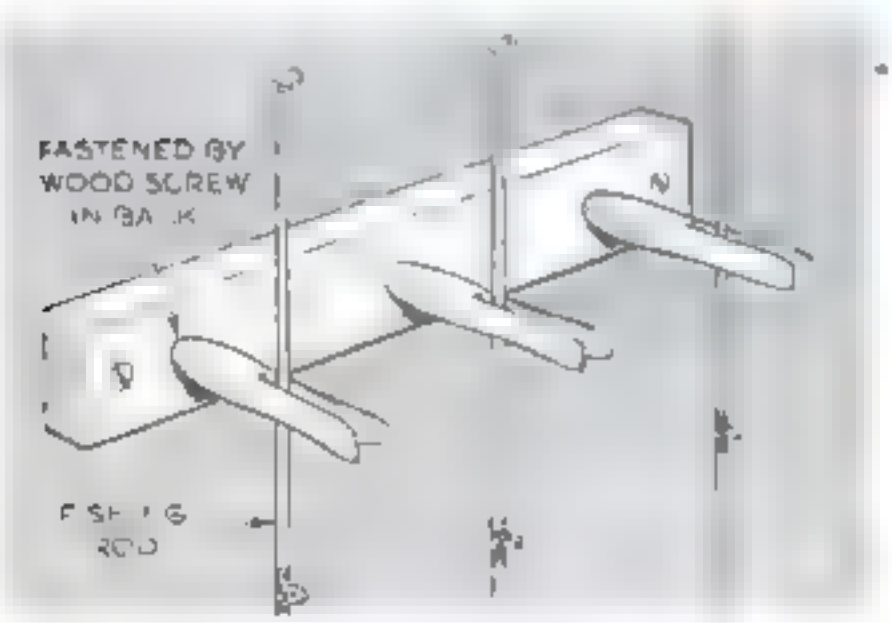
All-Wood Swing for Children Has Seat with Sides and Back





HERE is play-yard equipment that will delight small children. The swing is made entirely of 1" by 2" pine with the exception of three maple dowels and the boards forming the seat sides. A strap may be added at the front, if desired as an extra safeguard

Use ¾" dowels to join the slanting uprights just above the ground, and a 1" dowel at the top, waxing the last well at the bearing surfaces. Bore the pivot holes at some distance from the ends of the swinging pieces to allow for wear, and put a screw through the edge of each fixed member to keep the dowels from turning or coming out.—WILLIAM FREEMAN.

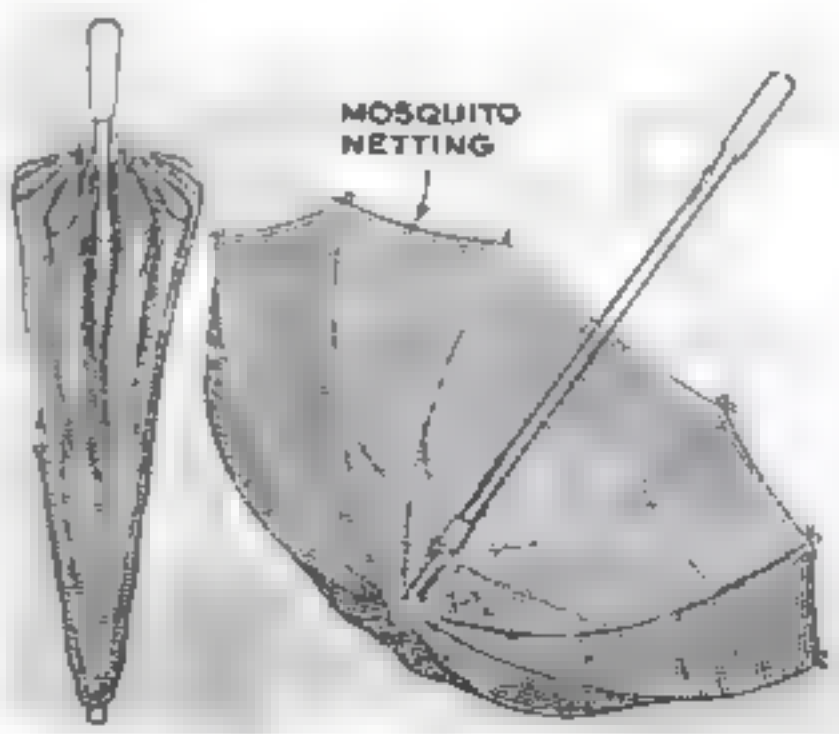


Simple Rack for Fishing Rods

ORDINARY wooden clothespins screwed to a light board backing, as shown above, will make a serviceable rack for hanging fishing rods upright both during the summer and at the end of the season. Drive countersunk screws through the back first, and then screw the previously bored pins onto the screws. Use screws long enough to extend into the pins for about 1", but not so thick as to cause any danger of splitting the wood.—WALTER E. HOFFMANN

Folding Minnow Net Is Made from Old Umbrella Frame

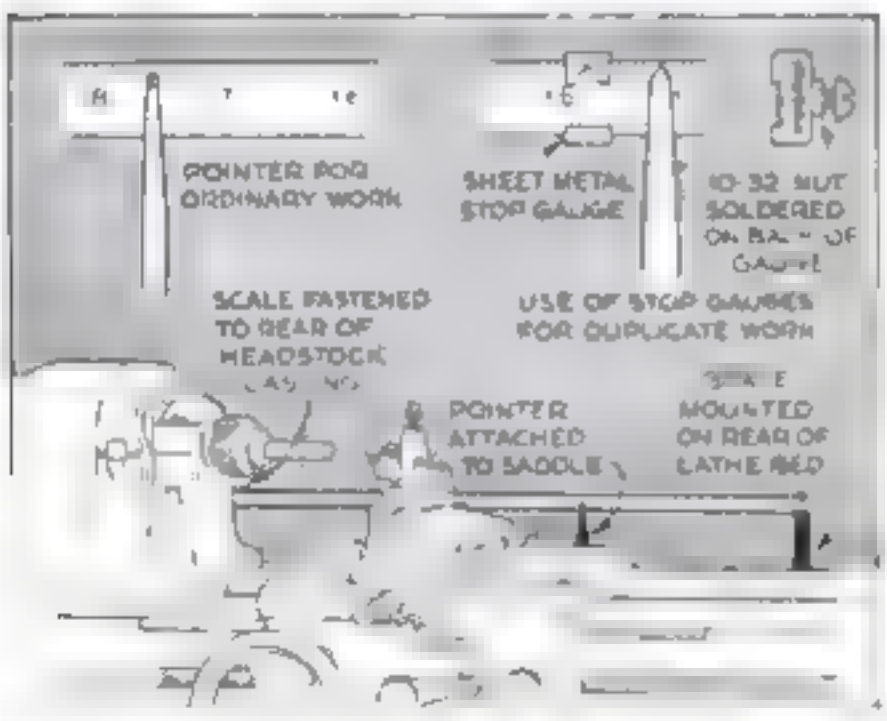
Mosquito netting on the frame of a discarded umbrella will provide an easily handled minnow net. Use one large piece of netting or several small pieces. In either case, sew the netting to the ribs with a rolling stitch, using linen thread, and finish with stitches through the eye at the end of each rib. Heavy cord from near the ends of the ribs to the handle will add strength to this convenient net.—H. W. SWOPE.



FINE PLASTIC PELLETS are used in sand-blasting machines by the Army Air Forces to remove carbon from airplane-piston walls and grooves without damaging the metal. These tiny pellets also polish the metal without abrading it. Made by the Tennessee Eastman Corporation, of Kingsport, Tenn., they resemble pellets regularly supplied to the molding industry except for their smaller size. They are tough enough to withstand the force of blasting and can be used over and over again.—ANDREW M. LAVISH.

This is the type of granulated plastic pellets used by the Army Air Forces to clean piston walls

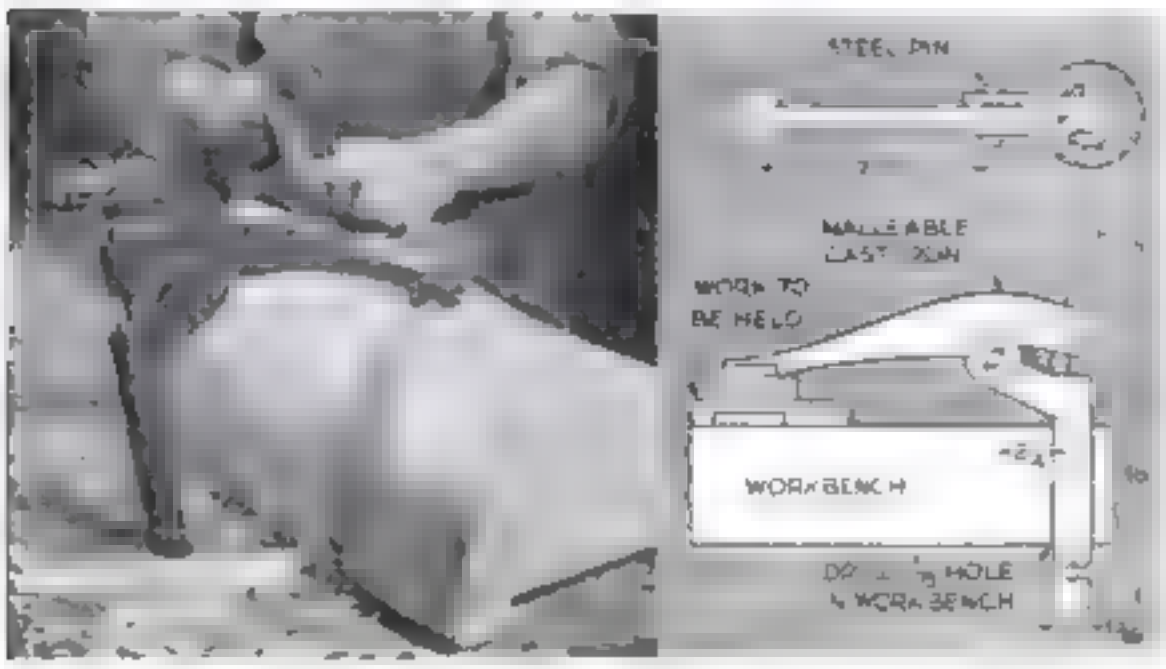
Carbon blasting is done so well in the Army that equipment is being installed by civilian airlines

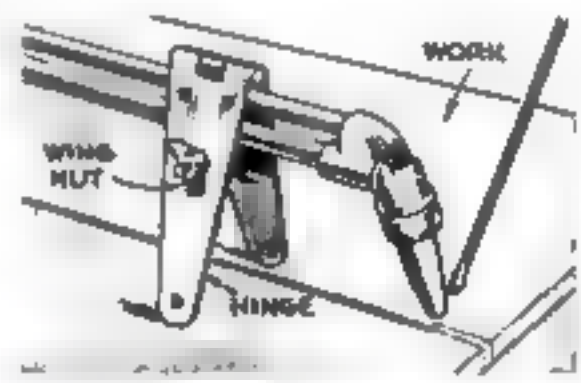


THIS LATHE LENGTH GAUGE consists simply of a steel pointer riding on the saddle and an etched steel rule attached to the headstock casting and to a brace mounted on the lathe bed. Two types of pointers are shown, one for duplicate work to be used with one or more stop gauges. Control, however, is visual rather than automatic.

At the Capitol Tool and Engineering plant in Columbus, Ohio, where it has now been installed on all lathes, the gauge has cut waste to two percent, especially by enabling operators to check on the tendency of work to slip in the chuck. The easily made device is useful in the home workshop as well as in a plant.—E. W. Ross.

FOR HOLDING WORK OF AN IRREGULAR SHAPE, the bench clamp shown below is slipped into a hole in the bench and the screw is tightened. When not in use, it can be quickly removed, leaving the bench top clear and free from obstruction. The clamp in the photo and drawing below was designed by Sylvester C. Bohe, senior carpenter in the U. S. Bureau of Reclamation shops in Denver, Colo.



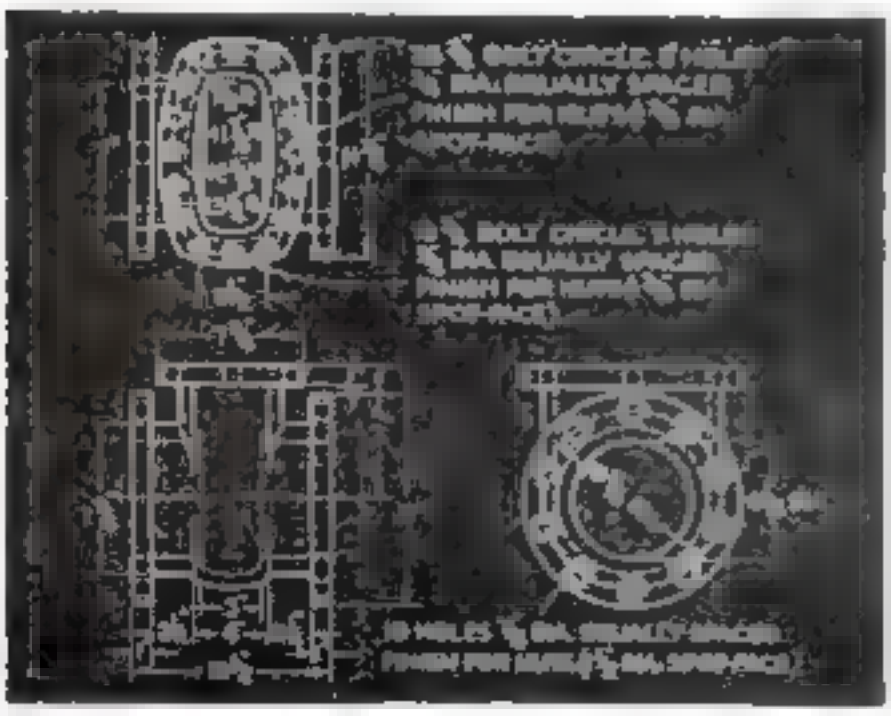


WELDING is done efficiently if the torch is clamped in an ordinary hinge, as shown above, so the nozzle can be kept a definite distance from the work. The simple device is especially helpful when it is necessary to weld a long seam neatly.—R. E.

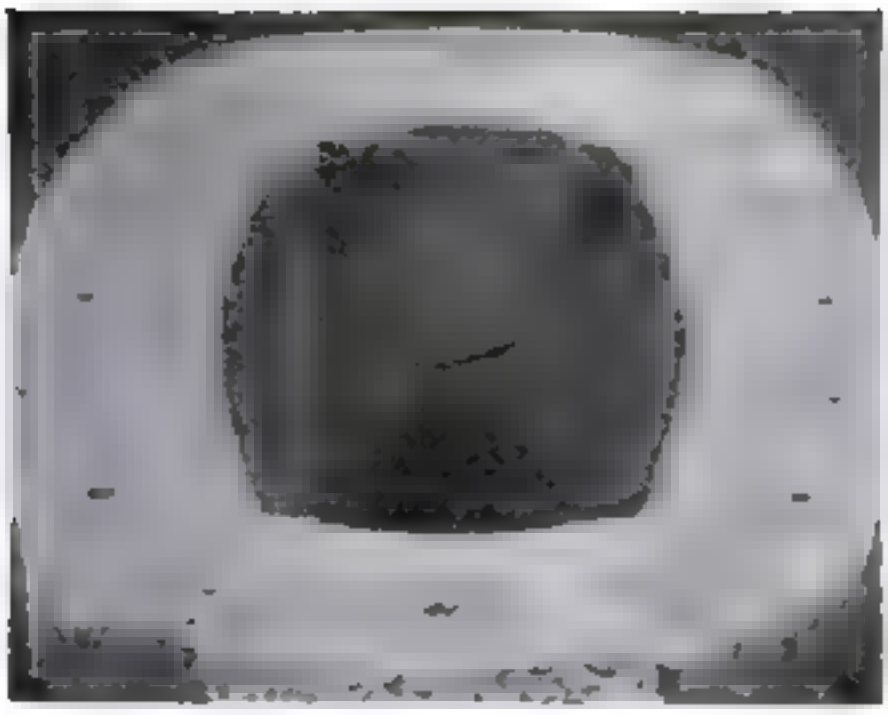
DRILLING AND SPOT-FACING OPERATIONS IN FINISHING A CAST-STEEL VALVE BODY

VALVE bodies of the type shown here need little exterior machining aside from that on the flange faces that will form pressure seals. Bolt holes, however, must be drilled in the flanges, and the surface around the holes is spot-faced on the underside of the flanges so nuts can be drawn up tight on the bolts. The accompanying photos show the procedure. They are from a movie produced by the U. S. Office of Education and distributed by Castle Films to aid in training workers in American war industries.

1 This valve-body job calls for the drilling of 16 holes ¾" in diameter in the top flange and 10 holes ⅞" in diameter in the other two. All these holes are to be spot-faced on the underside



2 Clamp the work lightly to an angle plate on the drill-press table and level the flange with a jack on each side; then draw up the clamps tight and enlarge drill centers with a center punch



3 Each hole is scribed with dividers set for the radius. Prick-punch marks at four points on the circumference serve to guide the drill. Note the enlarged central hole that helps start the drill

4 The radial arm is unclamped at the column and lowered with a power-driven screw to a height that permits using a short drill. This distance is judged by eye, and the arm is clamped in place

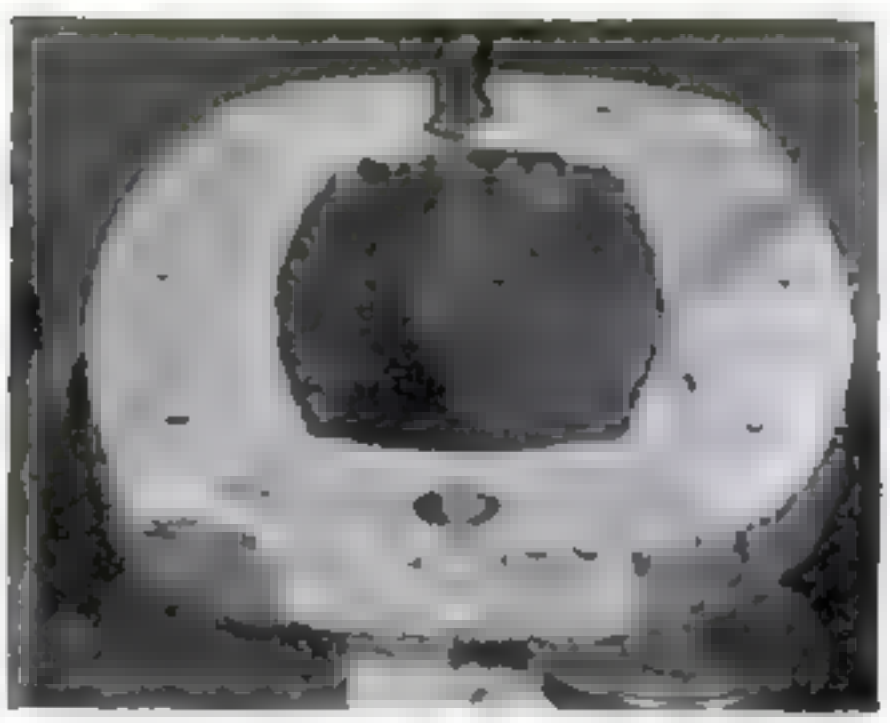
5 Since the work is set up for drilling the top flange, fit the ¾" drill in a friction chuck having a Morse taper that matches the drill shank. A ½" drill is required for the other two flanges

6 A chart on the drill-press column gives speeds and feeds. For a ¾" drill on cast steel, the speed should be 333 r.p.m. at a feed of .014" per revolution; for a ½" drill, 285 r.p.m. at .014"

7 Set the feed-selection dial on the drill head for the recommended feed of .014"; then set the gears at the base and in the drill head at the designated ratio to run the spindle at 333 r.p.m.

8 Loosen the drill head on the radial arm, and swing both the head and arm until the drill is centered above one of the center holes. You are then ready to test the position. [*Turn the page*]

9 Drill with the hand feed just far enough for part of the point to sink into the metal; then check to be sure the drill is centered. Above, a cape chisel is used to drift an off-centered hole

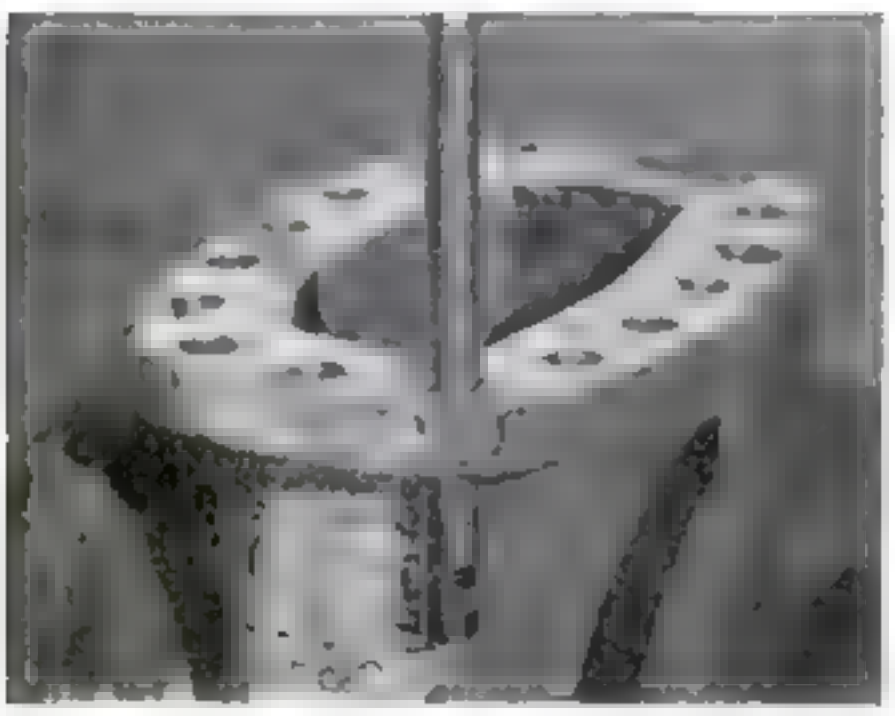


10 Drifting consists of chipping on the side to which the drill must be drawn. Try the drill again, taking care not to let the groove break it. A perfect hole cuts halfway into all punch marks

11 Once the drill is properly centered, advance it to the work by hand feed; then engage the spindle clutch and the automatic or power feed, and drill the hole through, using a cutting fluid

12 Raise the drill, unclamp the drill head, and loosen the column clamps so the drill can be swung over for the next hole. Center the drill as before and complete all holes in this flange

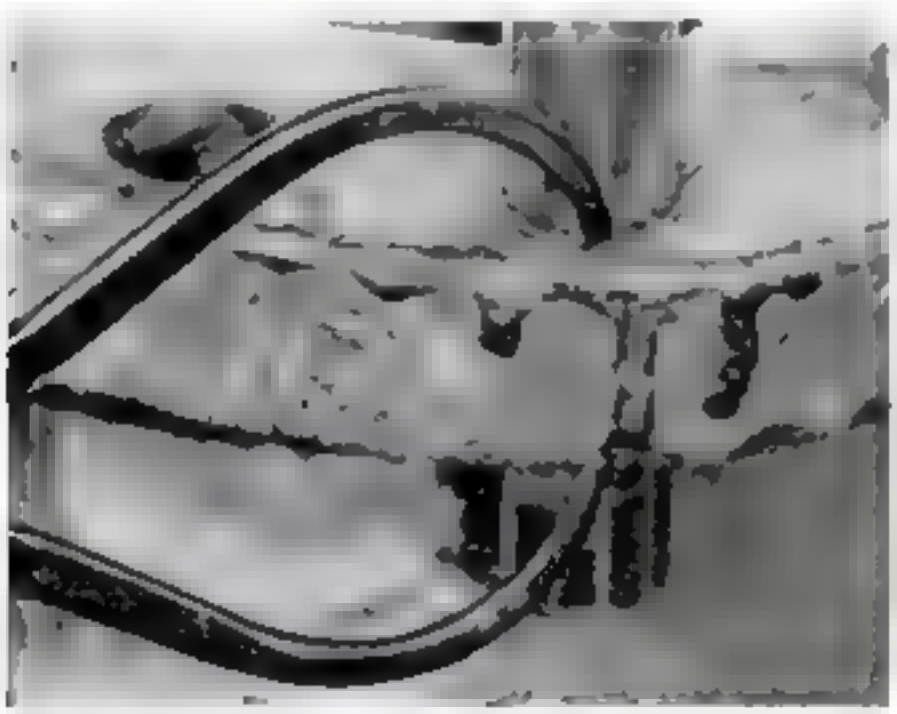
13 Next, the holes must be spot-faced under the flange. Lower the radial arm by power to a point that lets the spot-facing bar penetrate the holes; then drive the bar into the spindle socket



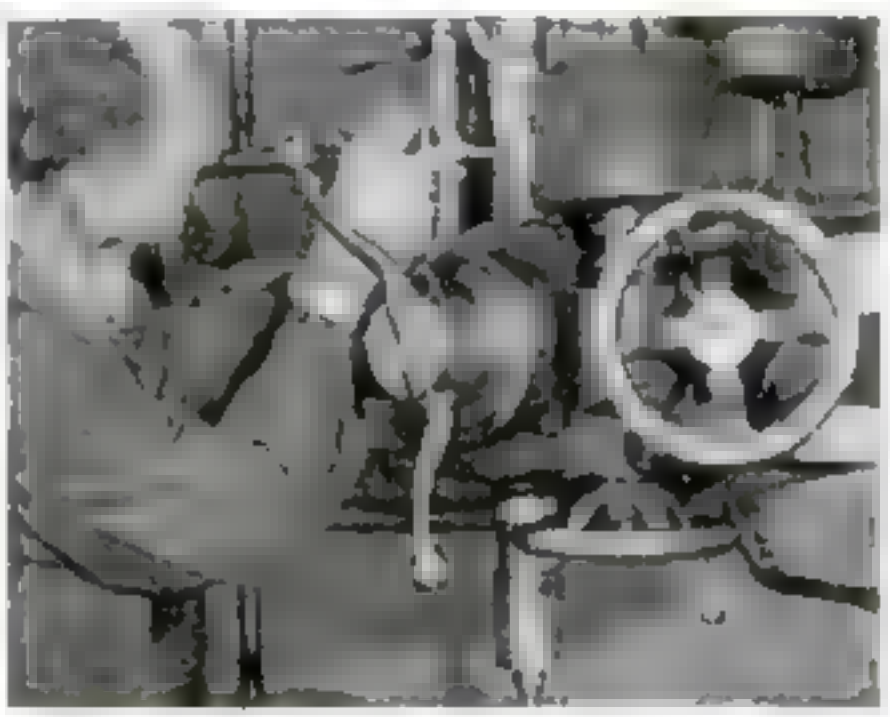
14 Since the diameter of the spot face called for is 1⅜", choose a tool that measures 1⅜" between the cutting edges, which are at diagonally opposite corners. Check with a rule

15 There is a small indentation at the bottom of the tool midway between the cutting edges. It is engaged by a setscrew at the end of the bar, centering the tool when the setscrew is tightened

16 Engage the spindle clutch and feed the tool into the work by hand, taking a fairly deep first cut to penetrate the scale without dulling the tool. Feed carefully for the remaining cuts



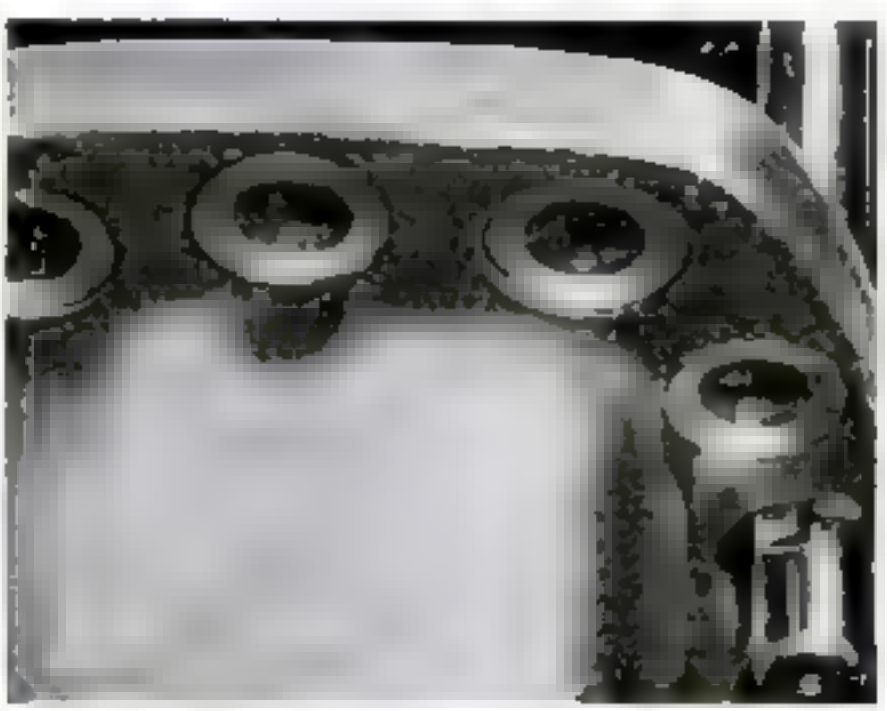
17 Check the flange for thickness with spring calipers set at ⅜". This dimension is not critical, but do not make the spot face too deep because this will weaken the flange at that point

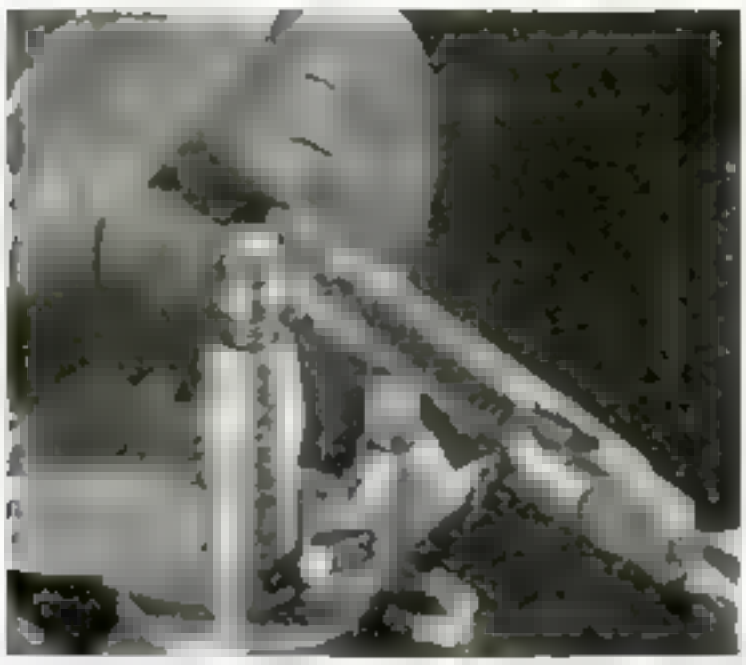


18 With the spot face at correct depth, set the automatic stop to disengage the clutch when the spindle has advanced the set distance. Thus, thickness need not be checked for the other holes

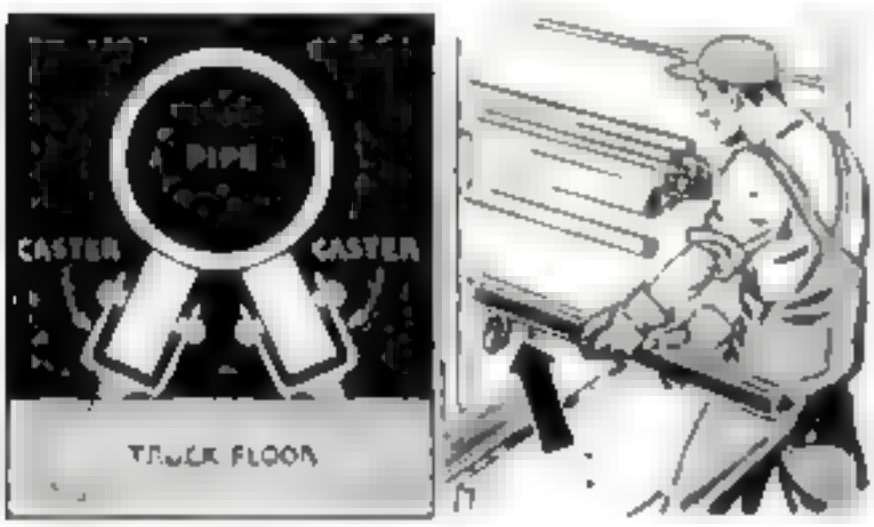
19 Move the drill head and arm simultaneously to insert and center the bar in succeeding holes. Use the hand feed for the first cut into the scale and the power feed for remaining cuts

20 Here is the finished flange with spot faces that let the nuts be drawn up tight in spite of an uneven surface on the casting. To complete the job, drill and spot-face the other two flanges



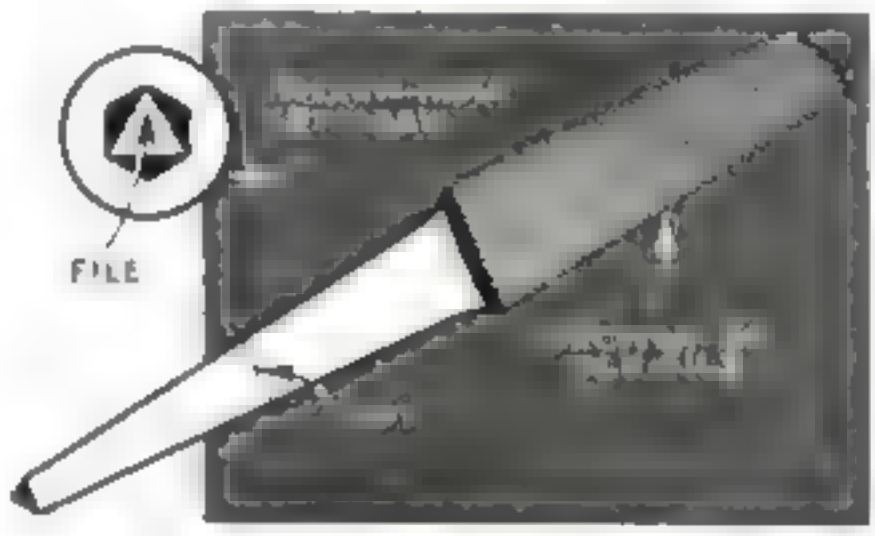


TAPER-SHANK DRILL SLEEVES make excellent replacements for damaged reducing sleeves in lathe headstock spindles if cut to a length that permits easy removal of a lathe center. Slip a drill sleeve on a tapered drill shank, chuck the drill and support the sleeve with the tailstock center, as in the photo at left above, and cut off with a parting tool. After discarding the unwanted end, move the tailstock center up to support the end of the chucked drill, turn the small end of the sleeve square and smooth, and finish by chamfering, as shown in the center photo.—C. W. W.

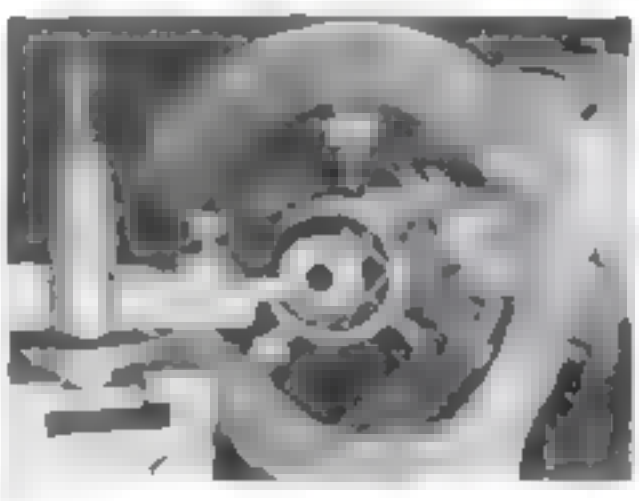


NONSWIVELING CASTERS, mounted in the floor of a truck or other place where pipes are loaded, will enable one man to handle long sections with little trouble. Bore two holes in the floor, as shown above, having them at an angle so the casters lean toward each other.—R. E.

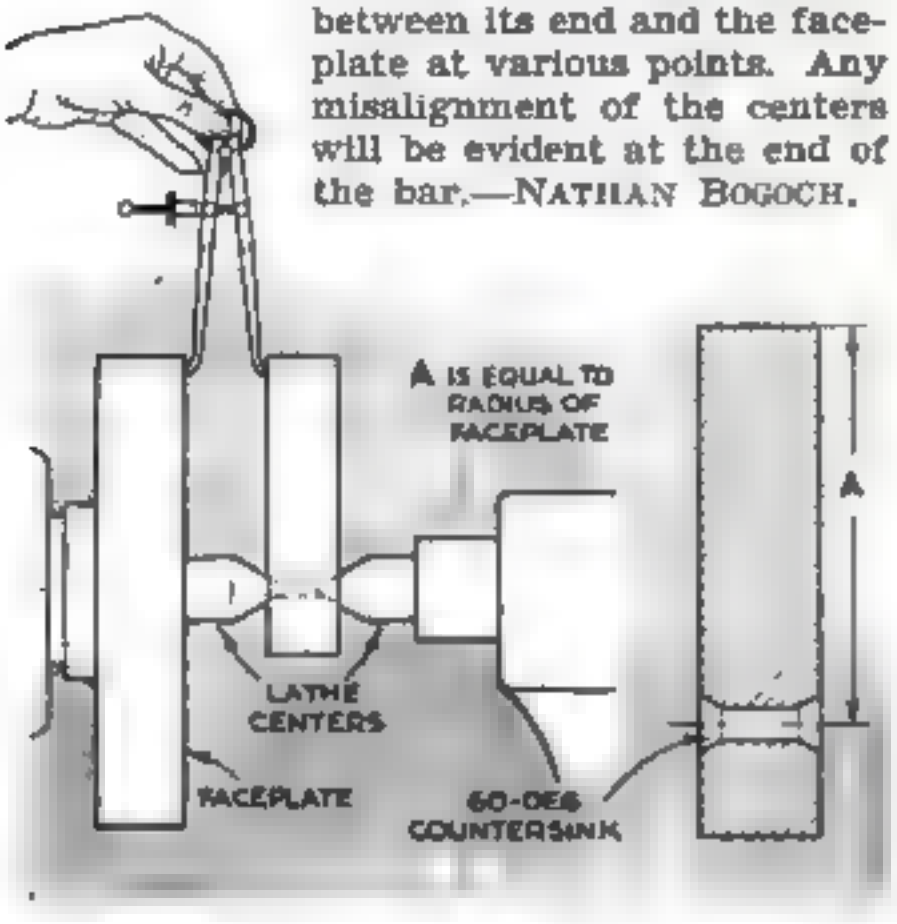
HOLLOW-HEAD SETSCREWS can be removed in an emergency with a discarded file. Cut the tang off on the taper for a snug fit in the head, and twist the file with pliers. A three-cornered tang will fit into three of the six corners of the head, while a flat tang will fit into four.—JOHN E. WILLS.

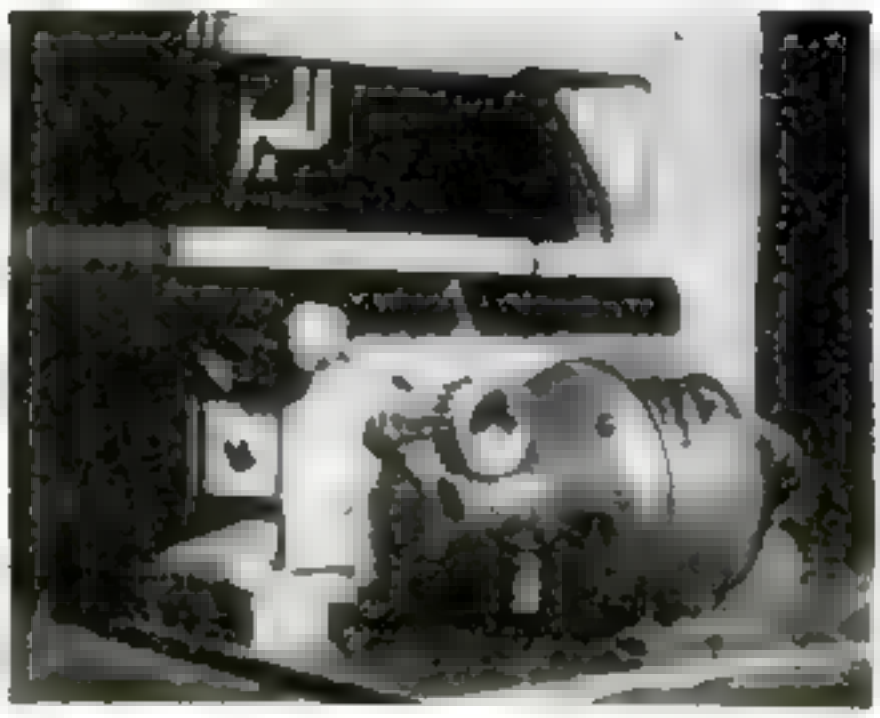


MAKING A CATHEAD for use with a lathe steady rest in supporting work of other than round shape is itself a simple lathe operation. All that is needed is a short length of pipe drilled and tapped for four machine screws at each end. Since most pipe is rough and somewhat out of round, machine a smooth bearing surface at the center for the steady-rest jaws. The pipe may be attached to a piece of stock, as shown in the photo at the far left, and mounted between centers, or simple chucking may suffice. If a tool-post grinder is available, polish the bearing surface with it. When you make use of the cathead, do not tighten the screws too much.—J. M. AVERY.



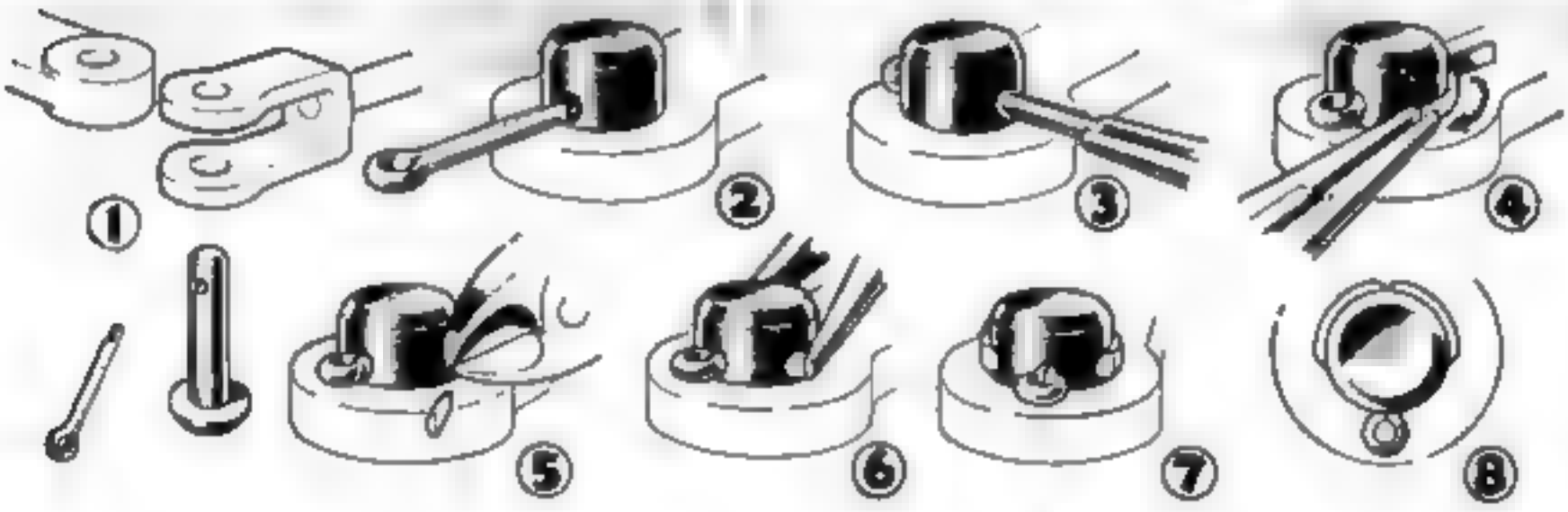
ALIGNMENT OF LATHE CENTERS may be tested quickly with a wobbler bar that can be made simply by drilling a hole through a bar, as shown below, and countersinking both sides. Rotate the bar between centers by hand, testing the distance between its end and the faceplate at various points. Any misalignment of the centers will be evident at the end of the bar.—NATHAN BOGOCH.





RIGGING UP A WOOD BANDSAW for cutting metal can be done by substituting a worm and worm wheel for the original pulleys and using a steel-cutting blade. Select a gear ratio to give a blade speed of about 120′ per minute. Mount the saw and motor on a steel plate, shimming the saw, if necessary, for a good mesh. A 1/6-hp. motor provided with a thrust bearing works satisfactorily.—J. C. MAGEE.

STEPS IN INSERTING A COTTER PIN TO ANCHOR A CLEVIS JOINT



1 When a linking arm is put in a clevis and a clevis pin is inserted, the joint is made safe with a cotter pin. The steps illustrated are approved by the Douglas Aircraft Company

2 With the clevis pin in place, the entire hole should just show. Use a cotter pin fitting the hole and turn its head so that this part is at right angles to the clevis-pin axis

3 Push the cotter pin through the hole until its head presses snugly against the clevis pin; then grasp the end of the longer leg of the cotter pin with a pair of long-nose pliers

4 Being sure that the pliers have a firm hold so the cotter pin will not be able to slip back in the hole, pull the longer leg around the shank of the clevis pin as far as possible

5 Then, using diagonal cutters as shown, cut a small piece on a slant from the end of the leg so the part that remains will reach a little more than halfway around the clevis pin

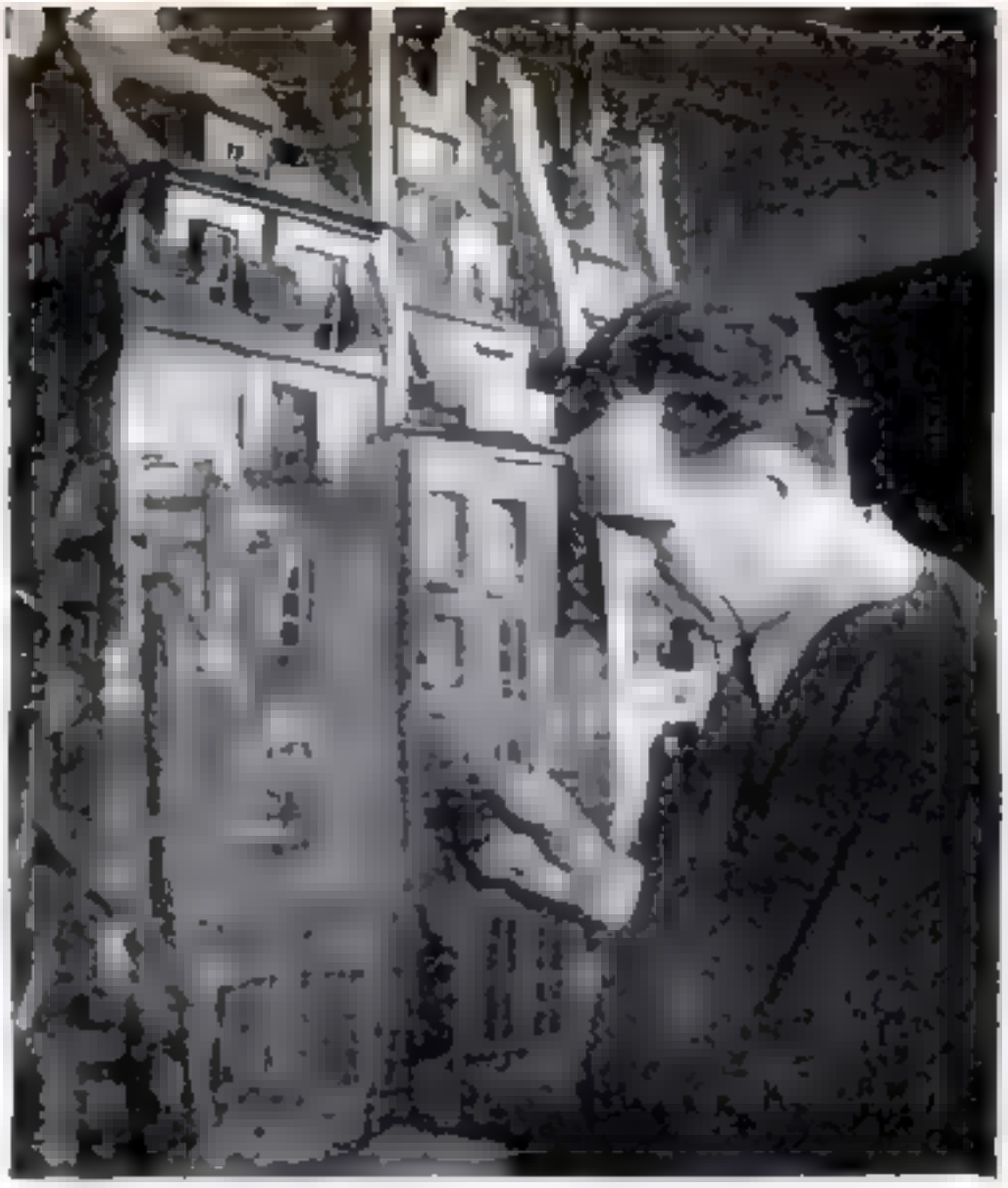
6 Again using the long-range pliers, squeeze the leg of the cotter pin tightly against the shank of the clevis pin. The diagonal cut on the leg should then taper toward the shank

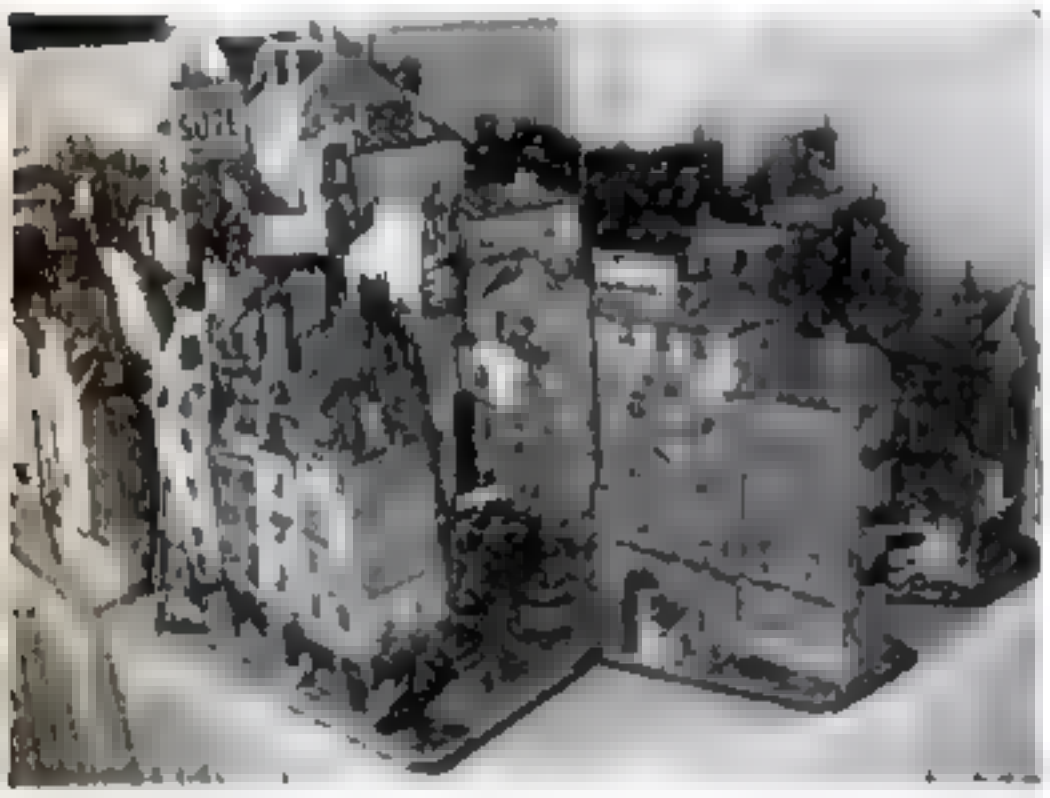
7 Next, the shorter leg of the cotter pin is pulled in the opposite direction around the shank, cut off on a slant at the same distance, and likewise pressed tightly against the shank

8 Thus, the cotter pin will form a perfect anchor for the clevis pin and will have no loose ends to catch on other parts. Two views of the completed cottering job are shown here

MADE IN HOME WORKSHOPS

PARIS IN MINIATURE, a model of an old and picturesque quarter of that city, is complete down to the smallest detail. George Alexander, American artist and illustrator, spent six years of his spare time in its creation. Completed in France and shipped to this country in 1940, it now is set up in Alexander's Los Angeles studio, where the nostalgic memories it inspires make it well worth the rather large space it occupies.

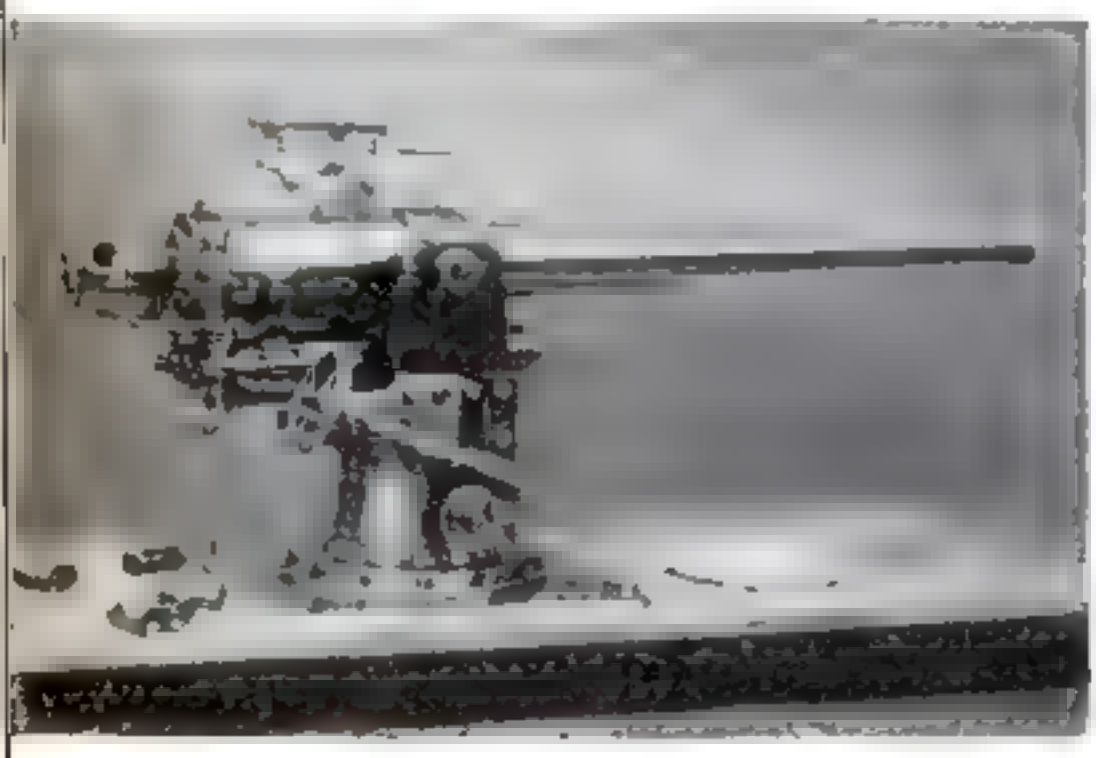


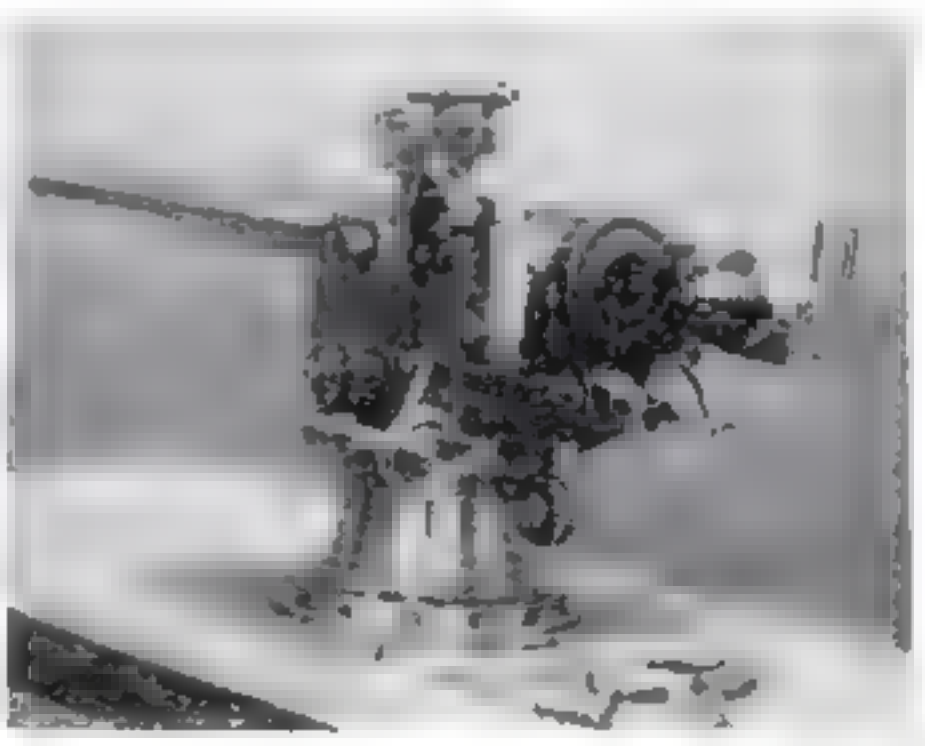


Perfectly scaled down to table-top size is this model of a labyrinthine section of prewar Paris

George Alexander, upper right, adjusts a lantern hung on a store in one of the narrow old streets. On the Place Sainte Genevieve, right, a vegetable display usurps a good part of the cobble sidewalk

THIS MODEL OF A 6" NAVAL GUN is a sample of the work turned out by British craftsmen between air-raid interruptions. It is 12" in over-all length (approximately ¾" to the foot), is set on a 4" square base plate, and has been built in such a way that it can actually fire .22-cal. bullets. A simple movement of the breech lever unlocks and withdraws the breech plug, which has an interrupted thread, and the gun mount revolves on a ball race. S. A. Walters made it of steel on a 5" lathe.





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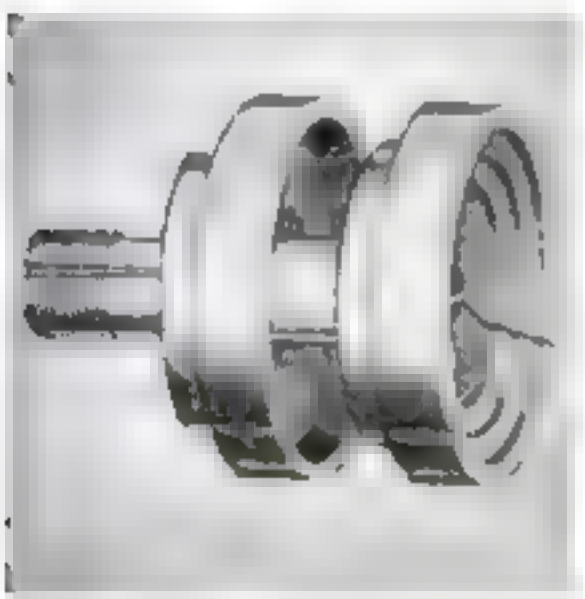

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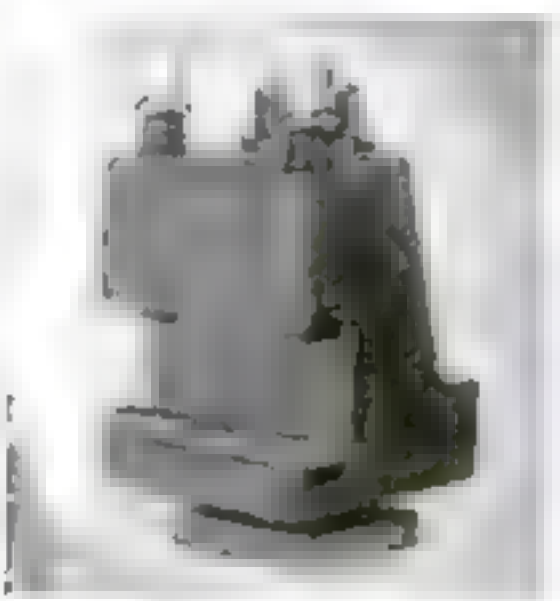

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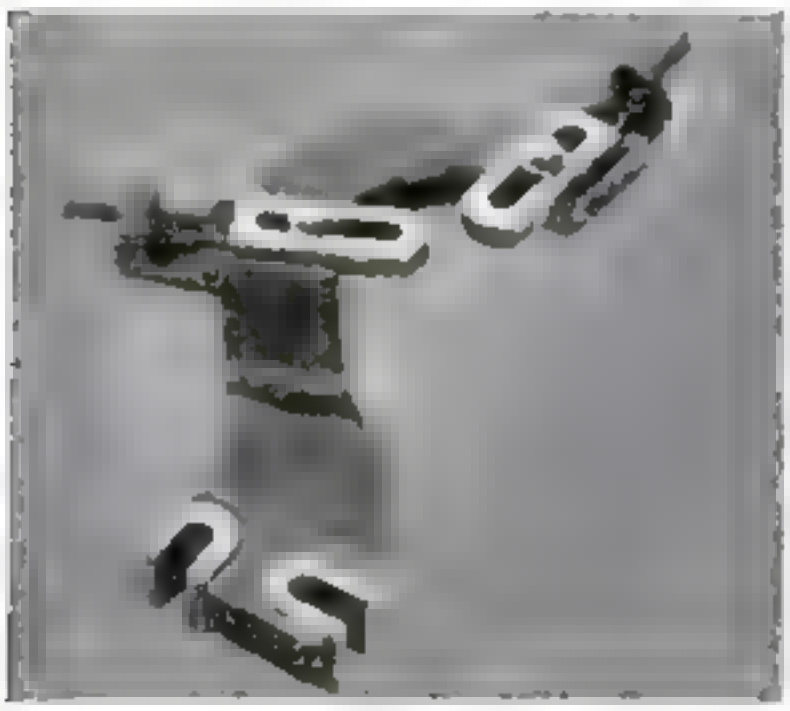

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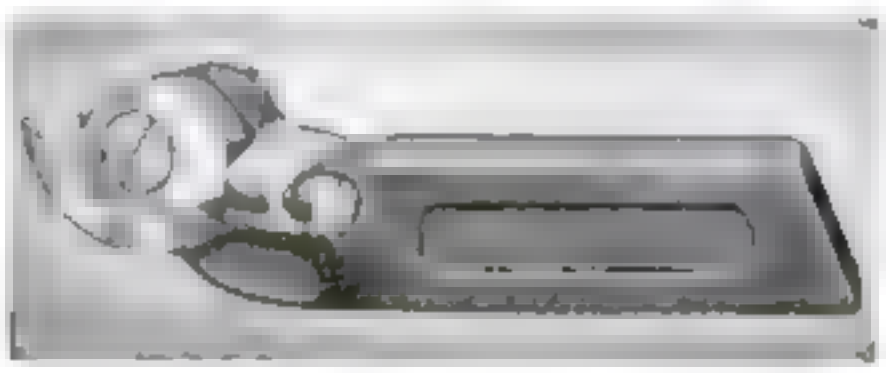
HERE are photographs of nine accessories used in lathe work. If you are familiar with lathes, you should be able to name most of them. Try it. Under each photo, in the space provided, write your answer; then turn the page upside down and check your accuracy.

ANSWERS

1. Clamp dog.
2. Safety dog and Allen wrench
3. Collet for round work
4. Step chuck and closer.
5. Open-side tool post.
6. Four-jaw chuck.
7. Follower rest.
8. Mandrel
9. Thread-cutting tool.

8_____



Photos courtesy South Bend Lathe Works

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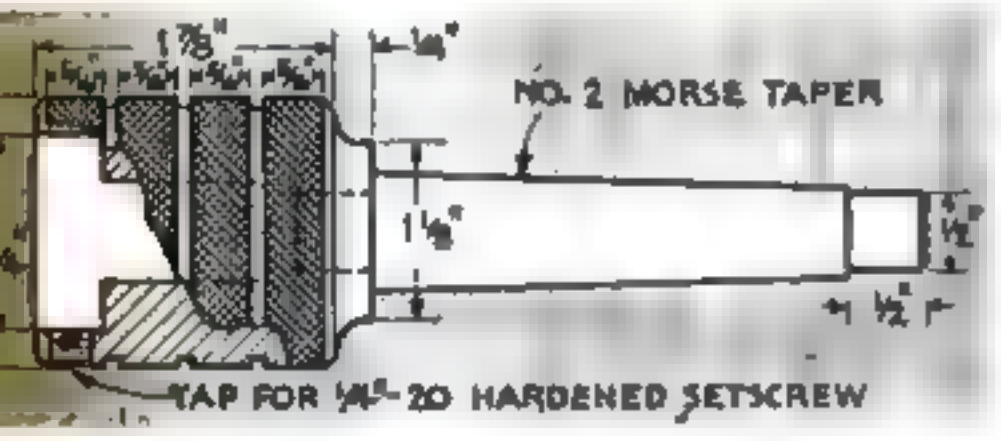


TAILSTOCK DIE HOLDER

Socket Speeds Accurate Threading in a Lathe

BY C. W. WOODSON

ACCURATE hand starting of a die is difficult if the die is mounted in an ordinary stock. If, however, it is rigidly mounted in the tailstock of a lathe and is square with the work, threads may be cut with sufficient accuracy of pitch for all ordinary purposes. Such a mounting, utilizing a special die holder that can be turned in your own lathe, is shown in use in the photograph at the left.

The holder is made of 1¾" diameter cold-rolled steel. Mount the steel between centers and knurl for a distance of 2⅛" in from one end. Then chuck it and set up the steady rest to turn the knurled end to the shape shown and to drill a ½" diameter hole, ⅛" deep, for fitting a Morse taper shank. From the end on which you have been working, measure off 2⅛" along the length of the work and, at this point, cut the stock off square.

Laying this piece aside for a moment, turn the shank between centers with a taper attachment or the compound rest set at the proper angle for a No. 2 Morse taper. Then turn the shoulder to a driving fit and drive it tightly into the holder.

Inserting the shank in the headstock spindle, drill and bore the holder to take a die. Here the fit should be snug enough to hold the tool without shake, but it should also be loose enough for easy removal of the die when a change of size is required.

Finally, clamping the assembly in a drill-press vise, drill and tap the knurled holder for a ¼"-20 setscrew.

In use, pressure should be exerted to start the die by feeding with the tailstock handwheel. After the first few threads are formed, the tailstock may be unlocked and allowed to travel on the lathe ways, accurately guiding the die as the rest of the threads are cut.

Although iron and brass may be worked without lubrication, plenty of oil of a suitable kind should be used when threading steel. Use animal or vegetable oils, or a special threading oil made for this kind of work, to insure smooth cutting.

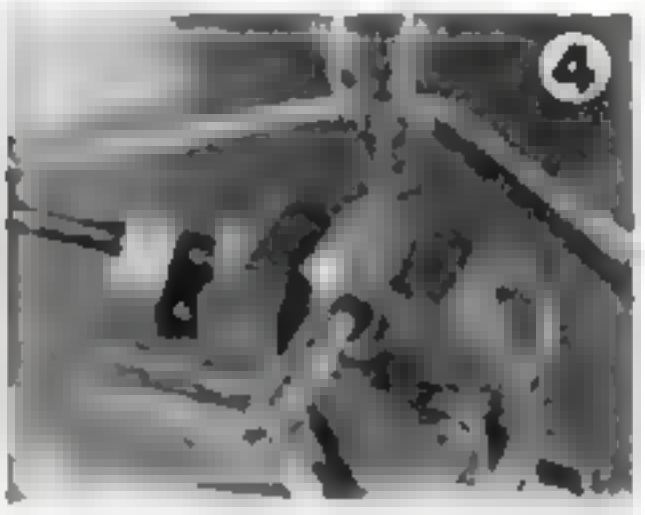
1 Knurl the steel holder stock for a distance of 2⅛" from the end

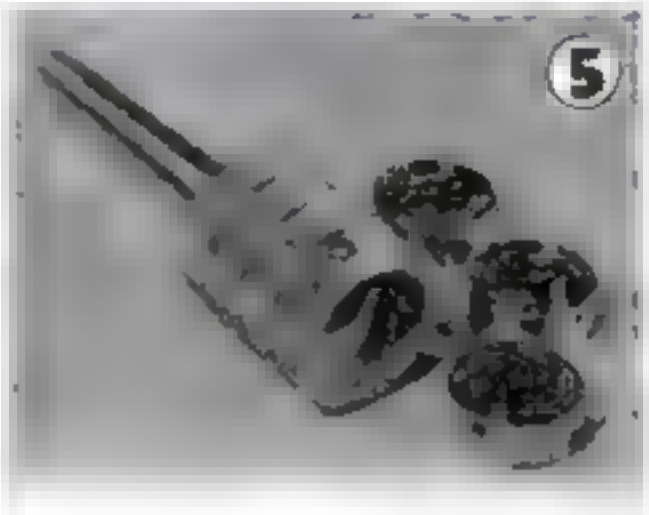
2 Chuck to turn the end to shape and to drill a ½" shank hole

3 Set the shank in the headstock to bore the holder for the die

4 Clamp the holder in a vise and drill and tap for a ¼" setscrew

5 The finished tailstock die holder along with some typical dies





Coolant Systems for the Small Shop

By WALTER E. BURTON

BASEMENT shops where work is done in spare time can often get along with drill-press and lathe coolants applied manually. But shops on an eight-hour or longer schedule, no matter how small, require some sort of automatic system if work is to be speeded and quotas are to be met. Such a system need not be expensive. A simple one for a drill press can be assembled from a 2-qt. can, an old metal darkroom tray, an automobile-radiator drain cock, and some flexible metal tubing, as shown below.

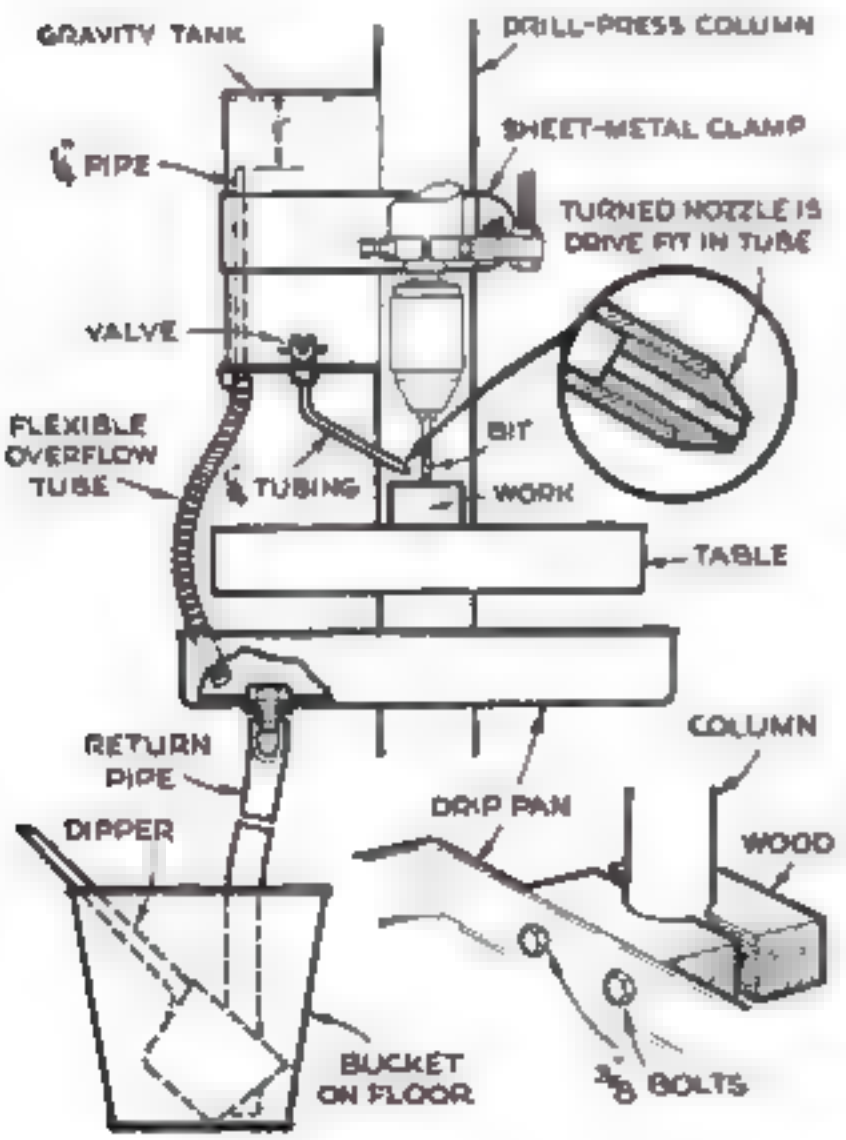
Fit the can with the drain cock and attach a piece of ¼" gasoline line tubing bent so one end will almost touch the drill bit. A length of ¼" pipe, run through a hole in the bottom of the can and soldered so its upper end is 1 ½" to 2" below the top of the can, serves as an overflow pipe. Connect to the protruding lower end a length of flexible metal tubing to lead to the return system.

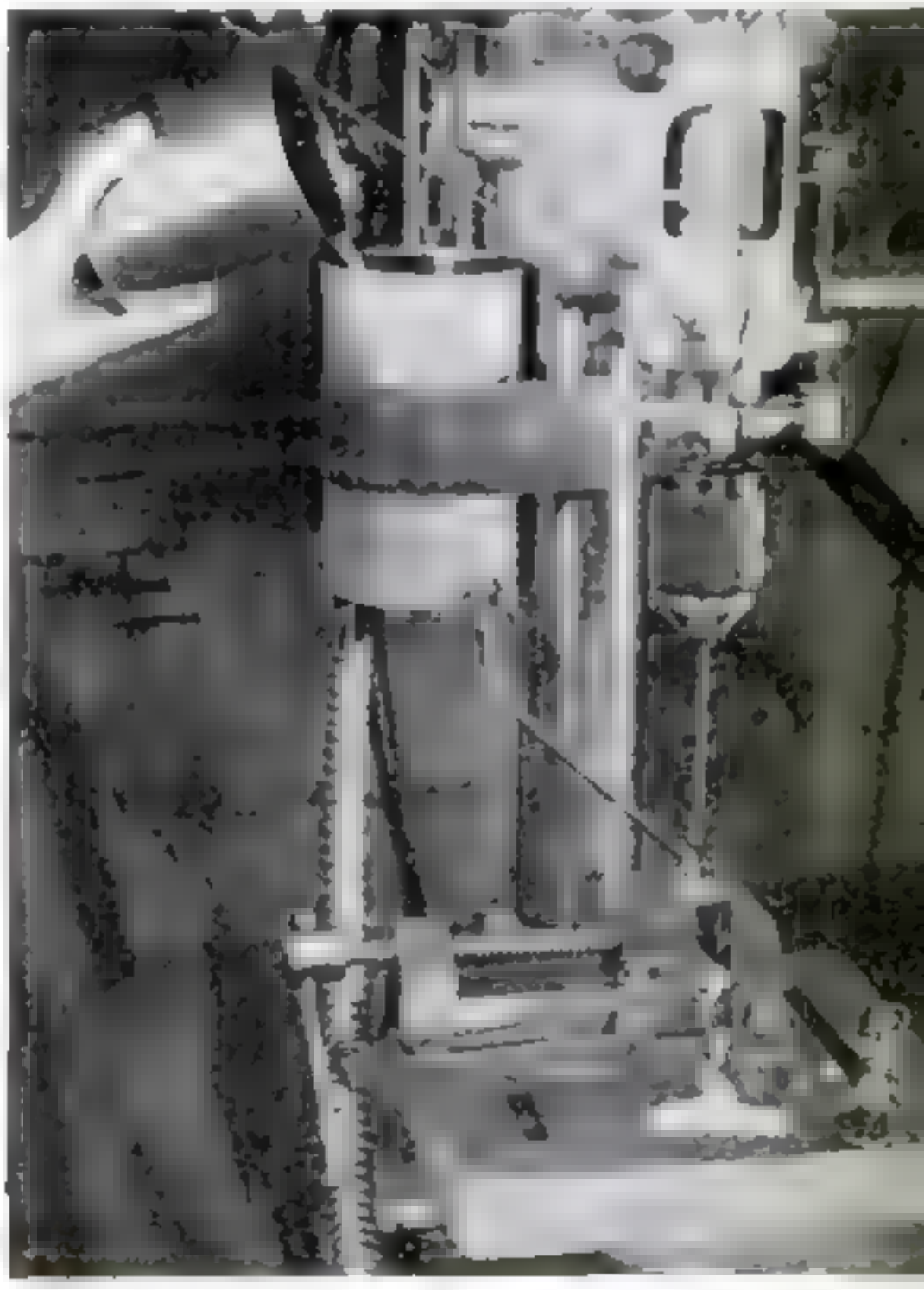
Hold the can to the drill-press column by a strip of sheet metal, a bolt, and a wing nut in such a way that gravity will permit a stream of cutting fluid to play on the bit and work. A nozzle on the end of the tube will keep the stream small. Mount the darkroom tray, 2" larger all around than the drill-press table, under the table to catch the coolant as it runs off and also to catch the overflow. A pipe bushing at one corner is connected to a flexible metal hose that leads to a bucket on the floor near the base of the drill press. Hand dipping from this reservoir refills the tank, which will hold enough coolant to last for a considerable time.

When a larger volume of coolant is used, as on a lathe, a motor-driven circulation system is desirable. The one illustrated on the following page is built around an old automobile oil pump mounted on a ⅞" board cut to fit over the top of a 5-gal. oil drum. Cut openings in the top of the

➡

Mounted on a drill-press column, this gravity coolant dispenser keeps cutting fluid flowing on the bit and work. A tray under the drill table returns fluid to a bucket on the floor

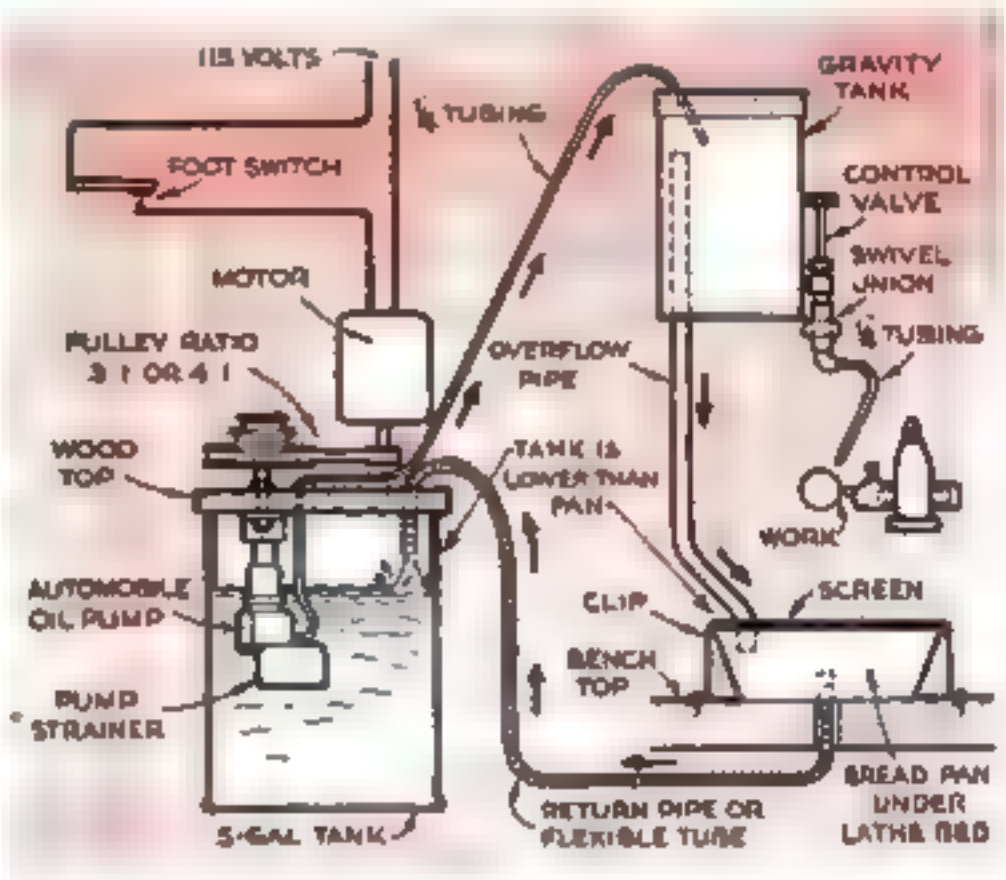




drum for the pump and output tube, and let the original hole take the return pipe.

An electric motor of about 1/20 h.p., operating at 1,750 r.p.m., drives the pump by means of a round leather belt and two pulleys having a ratio of about 3½ to 1. A motor designed for vertical operation is preferable, but one with a horizontal shaft may be mounted far enough from the pump to permit twisting the belt a quarter turn.

The gravity tank, connected to the pump with ¼" gas-line tubing, is similar to that on the drill press. From it coolant flows through a petcock and bent tube to the work. Excess, including overflow from the tank, is caught by the lathe pan and escapes through the conventional drain hole to a large bread pan bolted underneath. From there a length of ½" pipe carries it through the inlet hole to the pump tank. A screening arrangement keeps out chips. The pump may be operated at intervals by a foot switch, or a float-operated switch may be installed on the gravity tank.



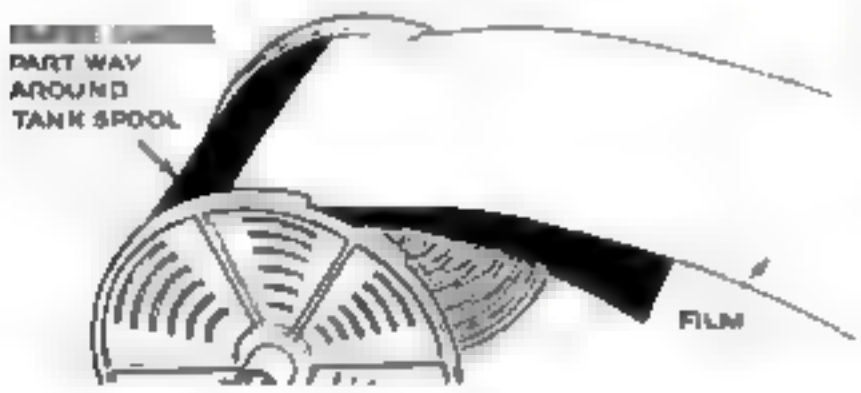
1 In a wholly automatic coolant system, a discarded auto pump, mounted as shown, keeps the gravity tank filled

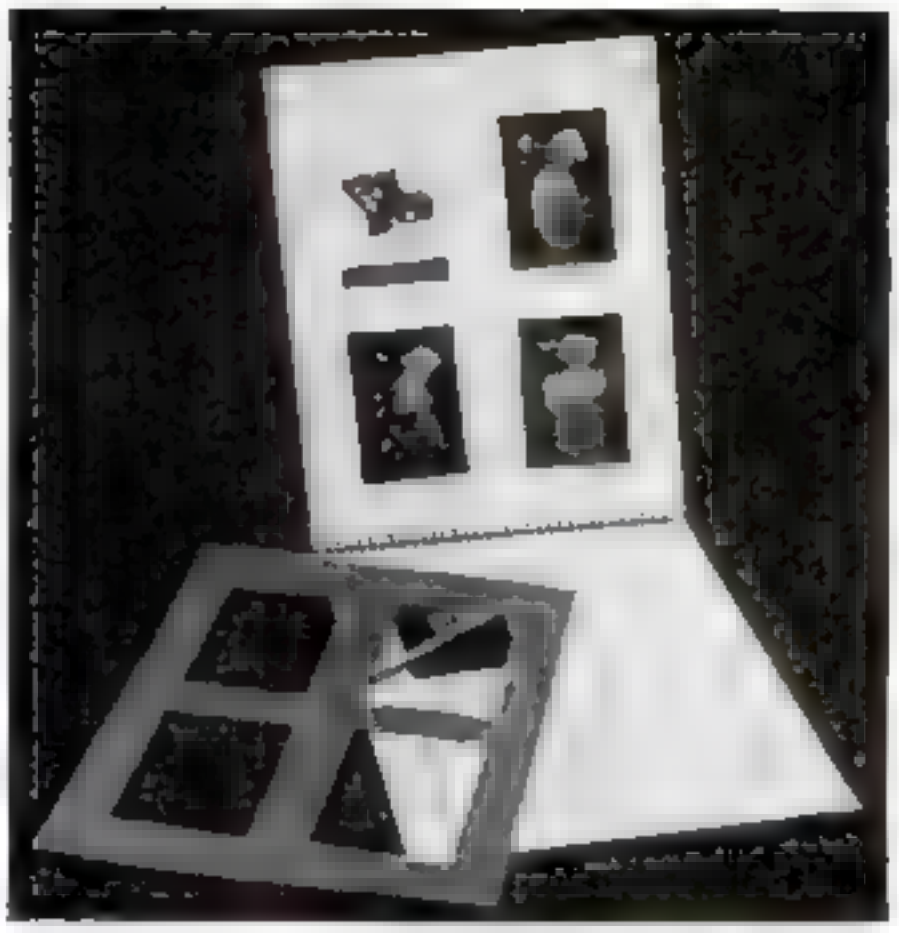
2 Here a vertical motor operates the pump. Use leather belting rather than rubber because oil won't hurt it

3 A gravity tank carries coolant to work in the lathe. Its overflow pipe holds it rigidly to a wooden upright

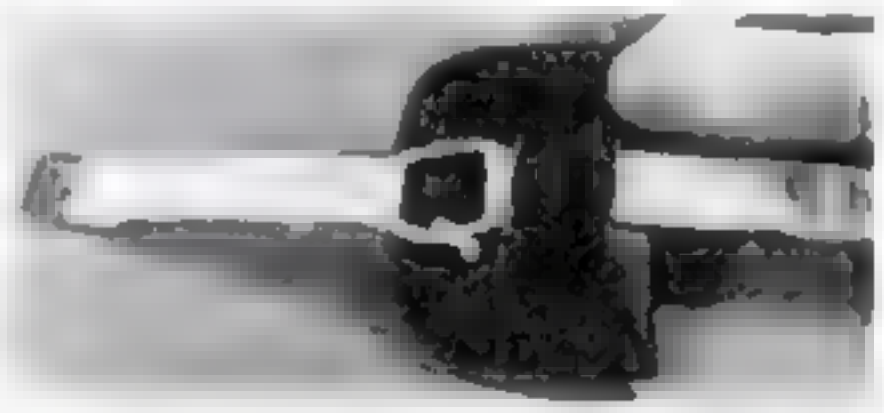
YOUR DARK SLIDE, when removed to take a picture, may be conveniently clipped to the bottom of the camera, as shown below. A fair-sized paper clip, fastened to the tripod socket with a ¼"-20 bolt, will hold the slide in place. The bolt may easily be converted into a wing screw by soldering half a washer in the slot.—LOUIS HOCHMAN

ROLL FILM is easily started into a film-processing reel by the method illustrated below. After stripping off the paper leader, cut a 6" length from it and insert this piece in the spool slot. Using the strip as a guide surface, slide the end of the film into the groove. When the film is correctly started, remove the guide.—O. FLUHARTY.





UNIFORM LAYOUT is a desirable feature in albums of contact prints. To obtain it easily, make a cardboard stencil from which you can trace the layout for an entire page. The cut-out rectangles should be ⅛" smaller than the prints so that the penciled guide lines will not show.—J. W. C.



A POUCH held to the wrist by means of a watch strap is convenient for carrying small camera accessories such as filters and cable releases. The strap ends normally on the watch are joined with cord.—R. S.

GLARE FROM A PHOTOFLOOD REFLECTOR can be eliminated by suspending a small tin-plate disk in front of the reflector bulb. To attach this simple diffuser, drill four holes through the disk—two an inch or so apart at the top and two, similarly spaced, at the bottom. Thread two lengths of wire through them, pull the wires taut, and secure the ends to a third wire that is drawn around the reflector beading.—HERMAN KLEIN.

WASHING FILMS AND PRINTS in sea water will reduce the time that it takes to remove hypo, yet, if precautions are taken, will produce nonfading images. G. T. Eaton and J. I. Crabtree, of the Kodak Research Laboratories, found that the salts in sea water dehydrate the gelatin in film, speeding the washing away of the hypo. To keep the image from fading—a tendency that is strong when a salt-water bath alone is used—finish up by washing the film in fresh water, thus removing the salts.

New Process Yields Color Movies

ALL the vivid colors of nature can now reach the motion-picture screen in their myriad shades by way of an ordinary single-emulsion black-and-white panchromatic film. Similarly, full-colored photographs like those reproduced in the color section of this issue of POPULAR SCIENCE MONTHLY may be printed from the same panchromatic film that is wound through your own camera. This seeming paradox is achieved by means of a process that converts colors into groups of varying densities of gray and then translates those grays back to the original colors again.

As the result of long experimentation by Richard Thomas, an inventor whose laboratory is in Hollywood, Calif., the new system makes it possible to show motion pictures in full color within hardly more than an hour or so after they have been taken. No special processing is required. The negative is developed in the ordinary manner, a positive print is made and threaded into a standard projector, and there follows the flashing of the scenes on the screen, all the tones appearing in their true natural colors. Of great importance to military intelligence, still pictures of enemy installations may be developed during a photographic reconnaissance flight and viewed by commanders in the field within a matter of minutes after the plane has landed, and in them the telltale colors of artificial camouflage can be easily discerned against the known shades and tints laid down by nature

Unlike other color processes now in use for movies and stills, Thomascolor, as the new medium is called, employs no dyes or tints. Until the very instant the images leap from the projection machine, not one iota of color appears anywhere along the line of its development.

Though the process requires extremely close tolerances in the manufacture and assembly of its few, nonmoving units, and represents the solution of many exacting mathematical equations, anyone using a camera equipped with a Thomascolor lens can take movies or stills for colored reproduction regardless of previous experience in color photography. Such pictures are made as easily as black-and-white photographs. The sole difference in operation is that one half of the Thomascolor lens is simply opened one full stop wider than the other half to compensate for loss of light transmitted by the optical system. This loss occurs chiefly in the filters.

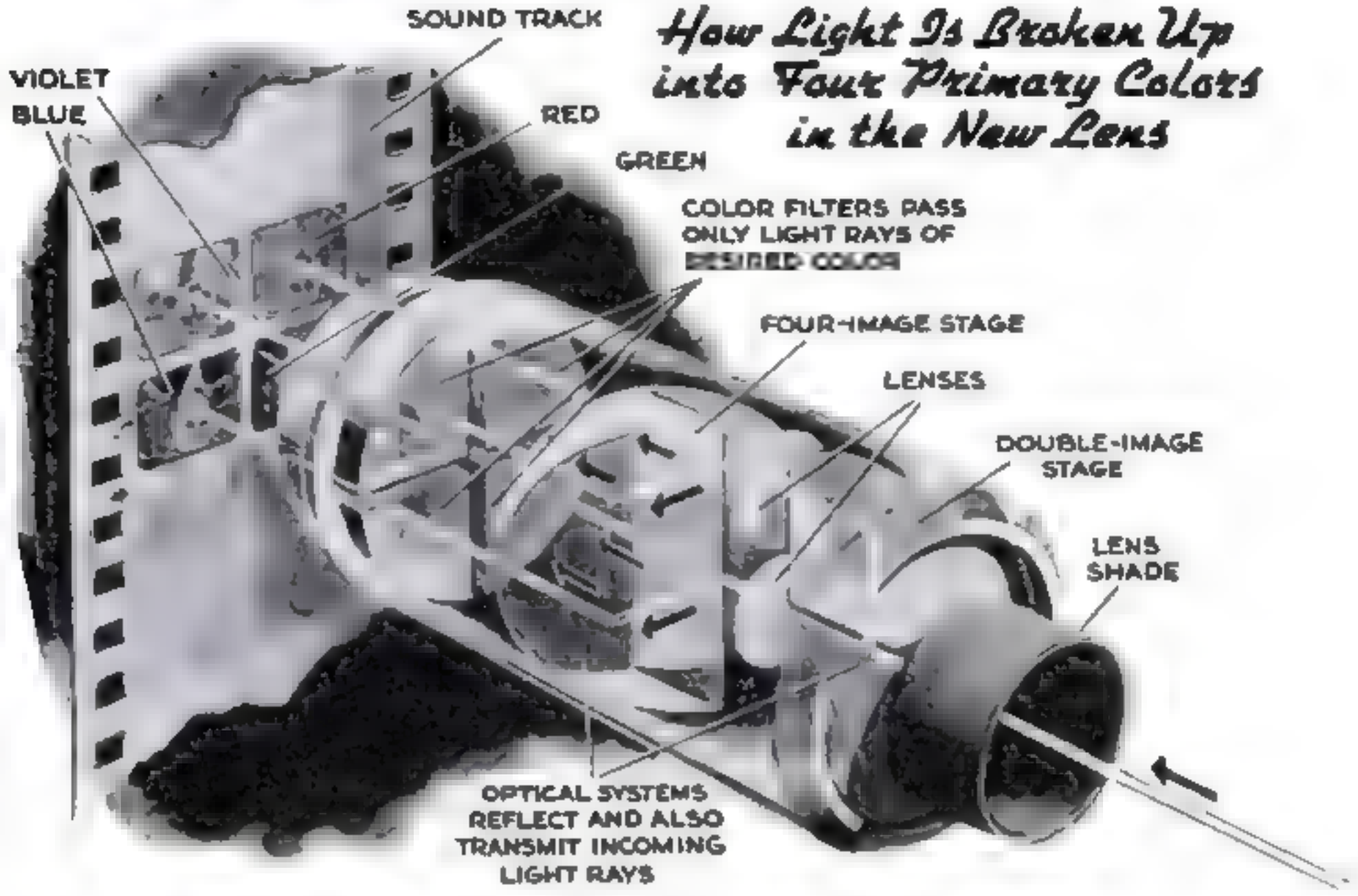
"The natural colors reproduced," says the inventor, "are due entirely to accurate color filtering and exposure in making the negative, and to proper projection and superimposing of the light flowing through the several filters which carries the picture to the screen."

What is it that takes place in this amazing process, and exactly how do pictures filmed in black and white leave the projector with all the colors visible during their filming?

A camera fitted to take Thomascolor pictures resembles any other outwardly with

Richard Thomas, the inventor, demonstrates his color lens mounted on a standard 35-mm. camera. By means of this lens both movies and stills taken with ordinary film are reproduced in full color

with Black-and-White Film

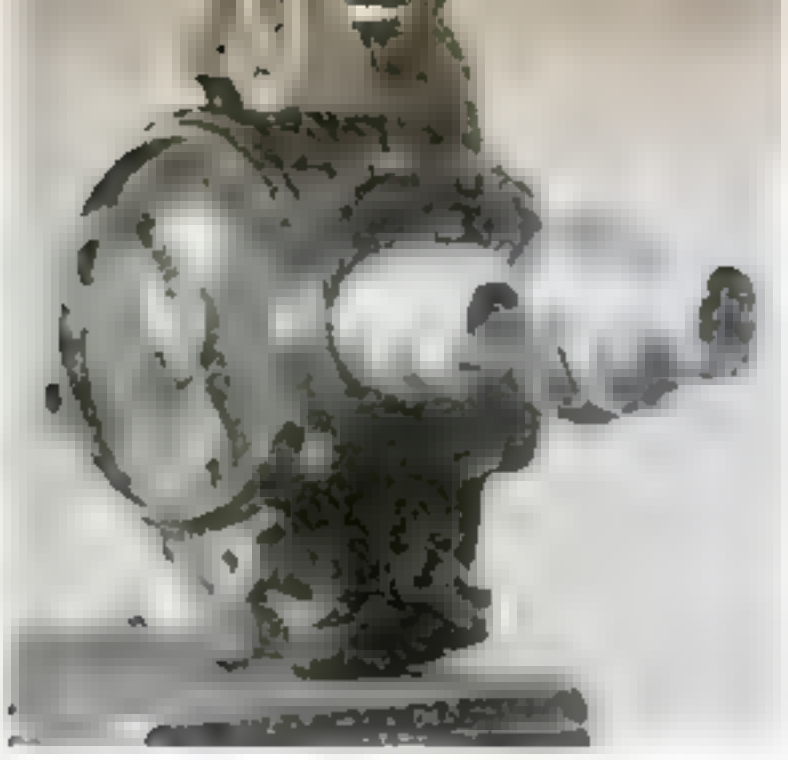


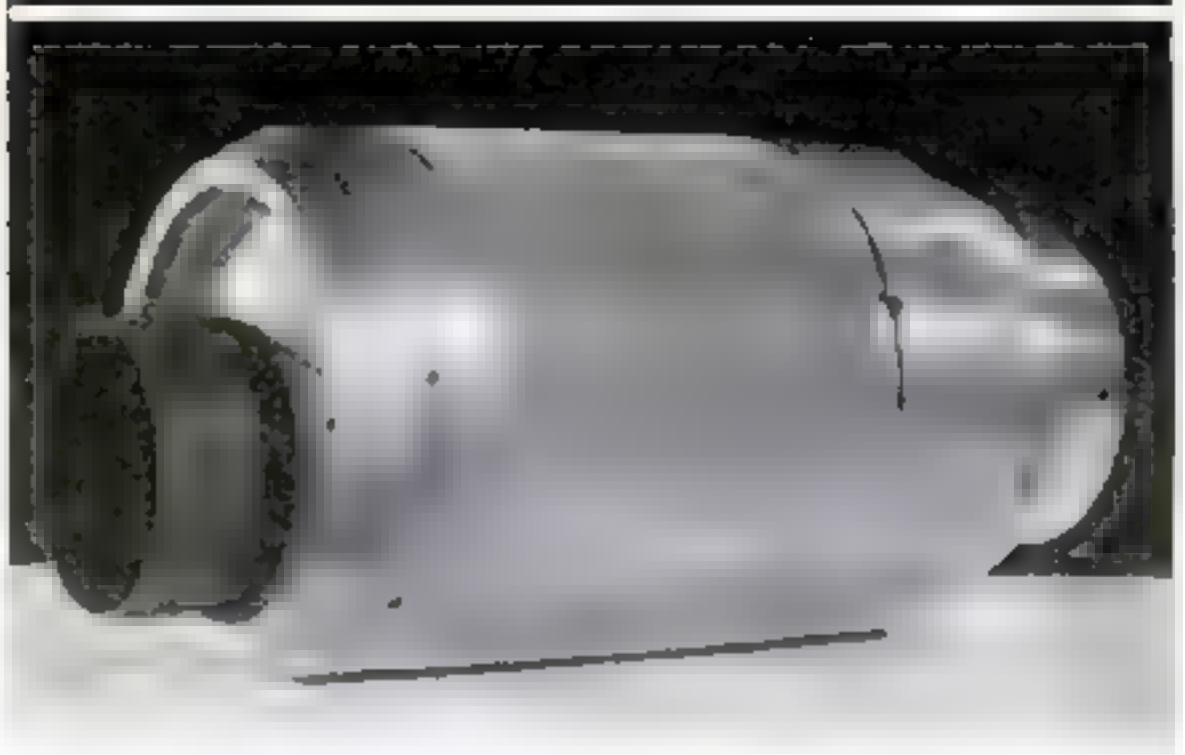
FOUR IMAGES are reproduced on a frame of standard film, each through a color filter admitting only its own kind of light. When these black-and-white images are projected through similar filters, the colors reappear

the exception that the optical system replacing the regular lens is slightly larger. That one difference is true for cameras taking either movies or stills. So little does the lens element add to the weight, however, that the one developed for use on a professional 35-mm. camera tips the scales at only 8 oz. more than the regular lens.

Within the Thomascolor lens element are two optical units that direct the light through a pair of tiny parallel lenses, one mounted on top of the other. The optical units bend some of the light at right angles so that all reaches the film plane from dead ahead. This is important, for the filters—red, blue, green, and violet, the four primary colors of this system of color photography—are so mounted in a plate container directly in front of the film that each produces an image only one fourth the size of the frame.

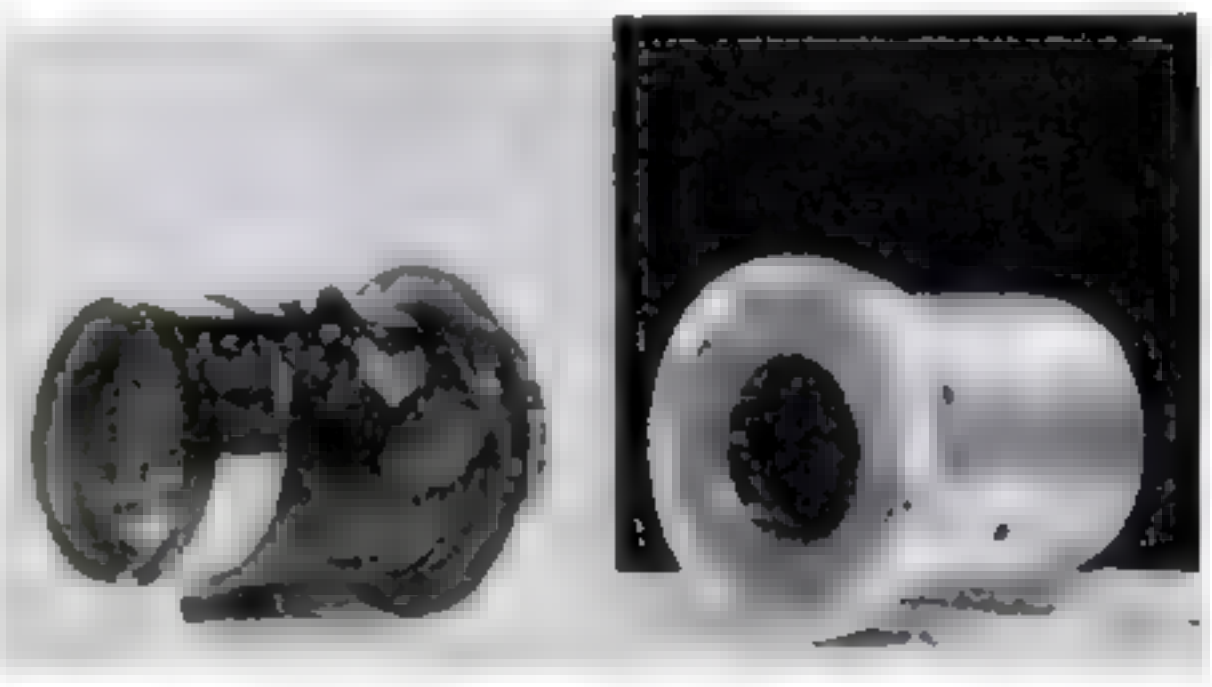
Each image, sent through a separate color filter, is recorded on the film in gray tones that correspond to the color values the filter passes. The red filter transmits red light only, the blue admits blue, the green sends





These are the key units in the new photographic process. Shown above are 25 and 50-mm. Thomascolor lenses mounted on the revolving turret of a 16-mm. movie camera, while below is a close-up of the Thomascolor lens that is used on a standard projector

Two optical elements and two standard lenses, each measuring ⅞" in diameter, are included in the Thomascolor lens. The one shown above is for use on a 35-mm. movie camera. Though larger than the standard lens, it weighs only 8 oz. more. At left, below, is a standard projection lens, while at right is a Thomascolor lens for a projector. These two are the same size, and few adjustments are required for interchanging them



green through, and the violet passes violet. Because the light is transmitted through a single aperture at the lens opening, and thus the four quarters of the frame have a single viewpoint, parallax is prevented. This explains why the four images, when properly superimposed on a screen, merge to become a single picture.

As an example of how color is portrayed on the screen, take a movie sequence that has been filmed by the Thomascolor process on ordinary panchromatic film. It is developed as is customary for this type of film, and a positive print is made. Then it goes to a standard projector for showing

Now for this projection, which is to be in color, filters duplicating both in color and thickness those used in taking the picture are placed between the lens elements. When the filters are in their proper positions and the projector is accurately focused, the images become a single, overlapping picture at any desired distance. And, though each of the four segments transmits only one fourth of the light, they transmit together as much light as would a single unit made in the ordinary way. Thus the screen is fully illuminated.

The keys to Thomas's achievement may be found in the ability of his lens to refract light with accuracy by means of the optical units it contains and also to cut off the unwanted colors in each filter. For years, toiling long hours in his laboratory, Thomas worked over his grinders and polishers, seeking a way to reduce chunks of heat-resistant optical glass to dimensions accurate within .000001". At last, he found he could grind the glass optically to the required perfect characteristics.

Meanwhile, he had another problem, that of cutting hundreds of tiny quadrants from larger pieces of colored optical glass, which also was heat-resistant. These, when finished, were to serve as the spectral filters. By the time-honored method of cut and try,

Thomas discovered at last how thick each filter must be to admit light of its own color and to admit practically none of any other color. Those thicknesses are: blue and violet, .112"; green, .115"; and red, .125". Because panchromatic film is especially sensitive to red, it was necessary to hold back some of the red rays by making this filter slightly heavier than would have otherwise been required. The filters that Thomas finally made were so perfectly matched as to color that, when light is projected through all four onto a screen without passing through a film, the colors are recombined to produce a pure white light.

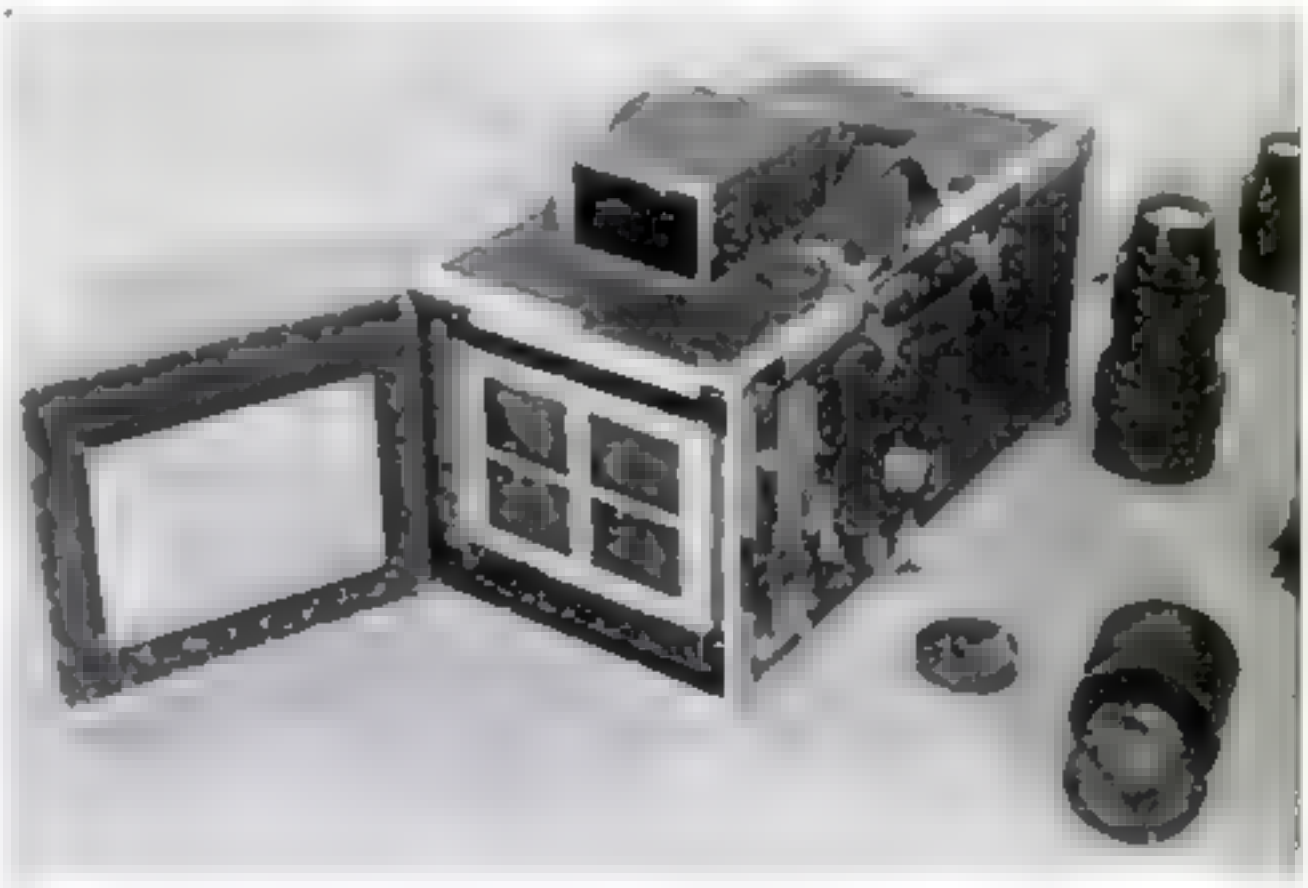
Computing thicknesses of the filters represents only part of the problem of filtering. The filters also had to be cut to proper size and to be accurately positioned in both the camera and the projector to within .0001". In order to obtain exact registration of the four images on each frame of a 35-mm. movie film and proper overlapping in the projector, each filter is cut exactly .322" by .425". Pairs are separated .050" vertically, while a gap only .031" wide separates them horizontally. This arrangement provides four identical 16-mm. images on each frame of film.

Because the fastest films may be used, great depth of focus is obtained. Still pictures have been shot on superpanchromatic film as fast as 1/1,000 second. No color correction is required in sunlight or under the white light emitted by photographic lamps. Illustrative of the compactness of the color head, Thomas has fitted 25-mm. and 50-mm. mounts to the revolving turret of a 16-mm. camera. Each yields four images approximately 8 mm. wide on each frame.

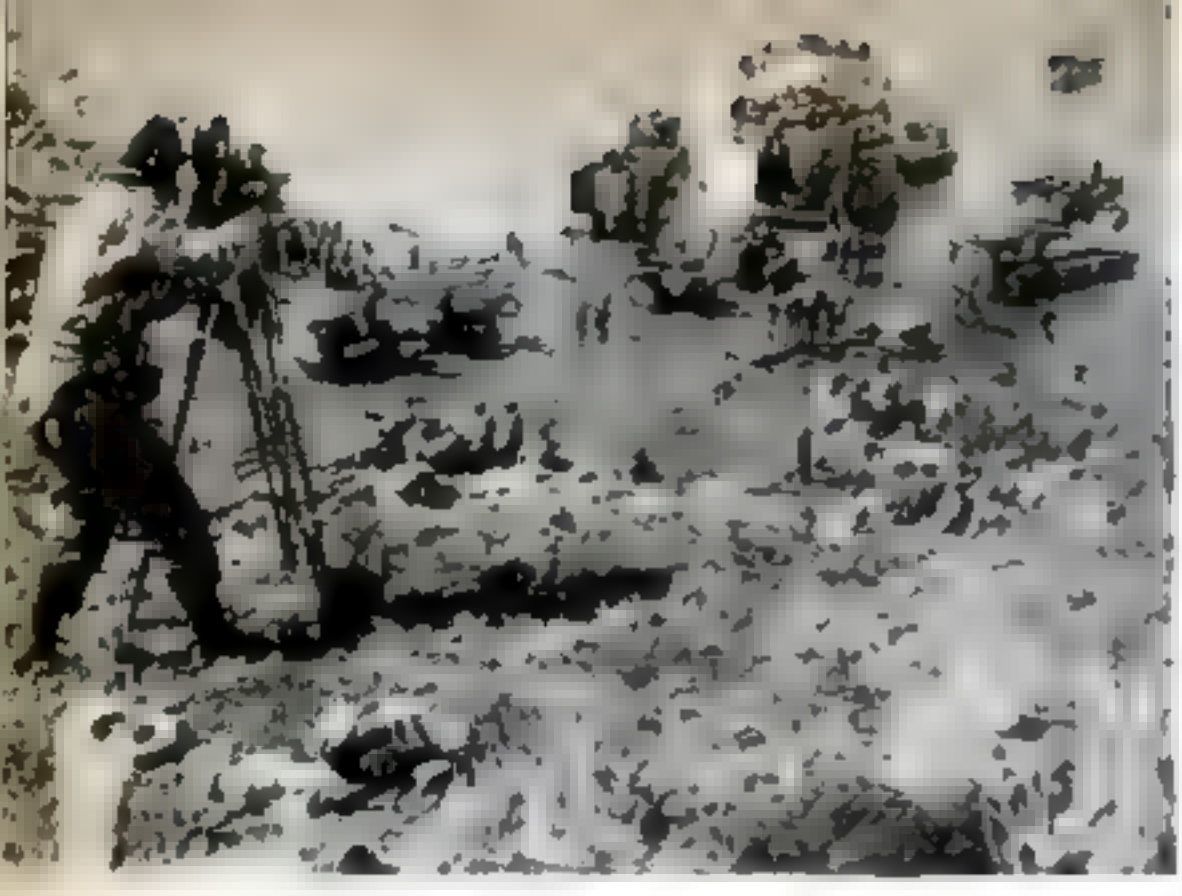
For military purposes, Thomas has developed a still camera that takes a 5" by 7" negative. A special projector throws colored reproductions on a screen. By changing filter combinations, certain colors may be held back and others accentuated, thus enabling the viewer to spot enemy installations that are invisible to the eye and to other color processes.

The new system of color photography, according to Thomas, will make it possible for the amateur to take, develop, and project his own color movies, or to develop and print color stills, in either print or transparency form. In his own darkroom or in the darkened kitchen, and with no other equipment than that usually employed in the developing and printing of ordinary movie film or still-camera negatives, the amateur follows established procedures. A paper print from either a movie frame or a still negative can be made by the standard carbro and wash-off relief method. However, matching the equipment to the average amateur's purse may have to await development of mass production.

So revolutionary is Thomascolor that it has been awarded seven basic patents. Since there are no colors to fade, when registered on so-called indestructible film, these quarter-size images may well provide the means for future generations to study our life and times in full color.



Still photos are taken with the camera shown above, in which the film is exposed through four filters. The viewer is on the top. Below, grays in the four separations are of different intensity, but when printed through filters, merge into one full-color print



Member of a combat photography unit the Navy cameraman at the left was in the van of the force that took over Kiska. He quickly set up his camera and is shown taking movies of the landing operations. At the right, a cameraman has snapped a fellow Marine firing at a Japanese pillbox in the Gilbert Islands

Action This Day as Seen

KISKA, the Gilberts, the Marshalls, Kwajalein. What did these words mean to us two years ago? Practically nothing. What do they mean to us now? We recognize them as being the names of now familiar places where our armed forces have fought and are fighting.

If someone mentions Tarawa to us, we can see in our mind's eye a small sandy island where once stately palms nodded and swayed to the urging of gentle Pacific breezes, but where now only a few stark tree trunks, nearly denuded of fronds, are left standing over one of the war's bloodiest battlefields.

Our mental image is so clear-cut, so well defined, partly because of the achievements of a group of unsung Americans: the combat photographers.

On Tarawa: Above, a Marine detachment is caught by the camera just as it is about to advance on a Japanese position. Below, the Marines charge in spread-out formation, carrying their guns in one hand and their entrenching shovels in the other

Frank Filan, right, who took the Marine pictures reproduced here, has been awarded a Pulitzer Prize for his work. With him is Capt. W. P. McCahill

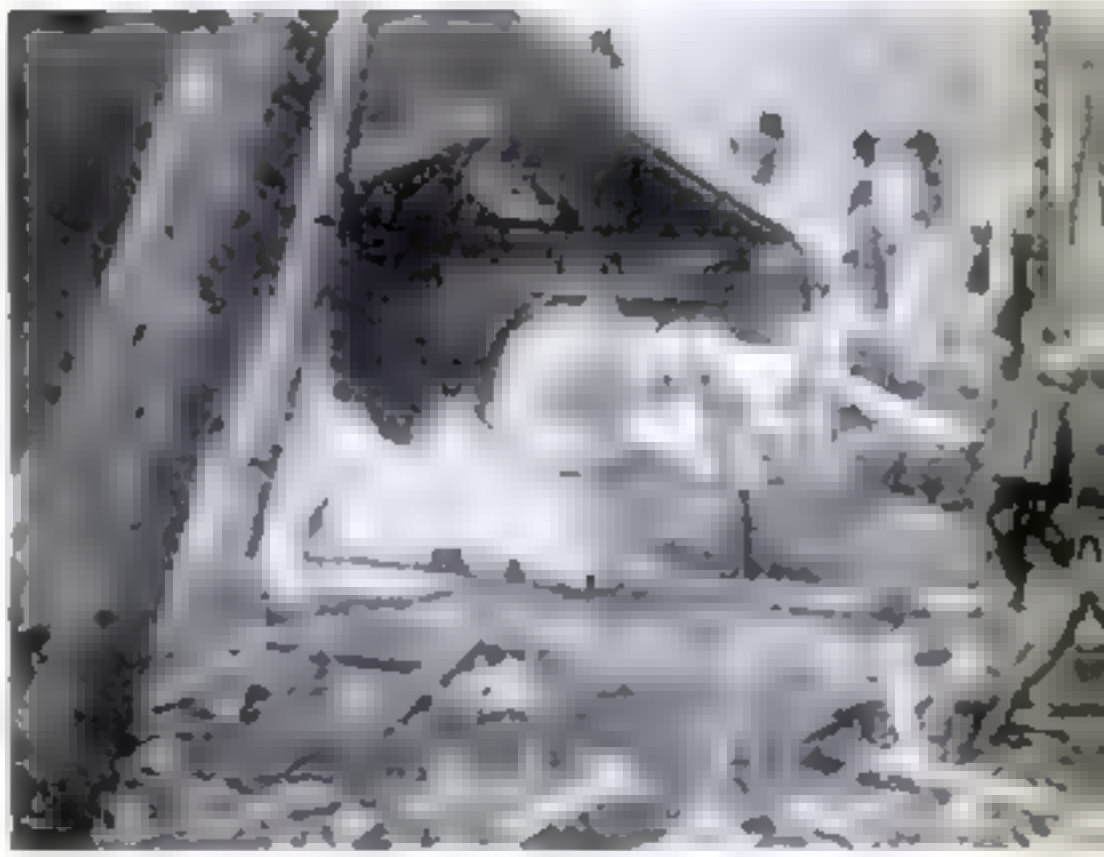
In the midst of the battle for Tarawa a front-line photographer took the picture at the left showing a Marine in the act of lobbing a hand grenade at the enemy. At the right the photographer has recorded a scene in which doughboys of the 17th Infantry are routing Japanese from their dugout on Enubuj Island

by Our Battle Cameramen

These men, with a disregard for personal safety as complete as that shown by the troops themselves, accompany combat units into the thick of battle, snapping shutters and grinding cranks as they go.

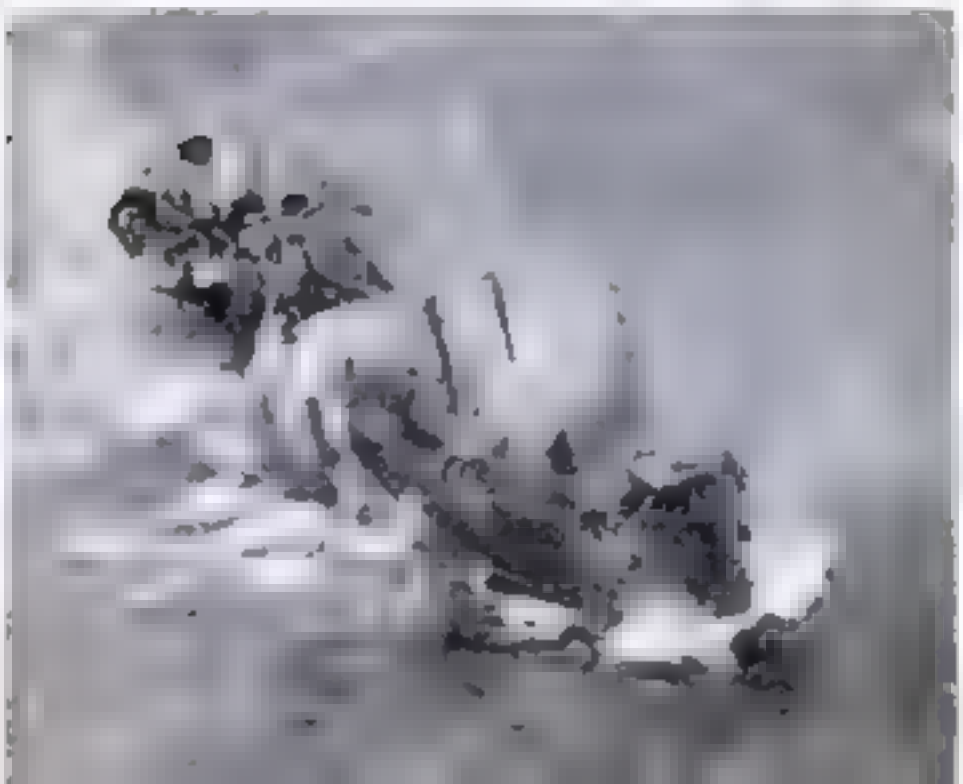
A few outstanding examples of their work, together with two pictures of the cameramen themselves, are reproduced on these pages. These photos have been taken from the official files of the U. S. Navy, Marine Corps, Army, and Coast Guard.

In civilian life, some of the men responsible for these pictures worked as newspaper, magazine, and news-service photographers. Others were Hollywood cameramen. A few were amateurs whose hobby happily proved to be extremely useful to the war effort. Now all are on active duty in the field with our fighting forces.



Using a flame-thrower, a Marine demolishes a Jap building on Namur Island in the Marshalls. Below, Marines pick their way across swampy New Britain Island to attack an enemy airfield. To get such photos, cameramen accompany troops to all fronts

Afire and in distress after a bombing attack by American planes, a Japanese freighter unhappily poses for an air-borne battle-front photographer



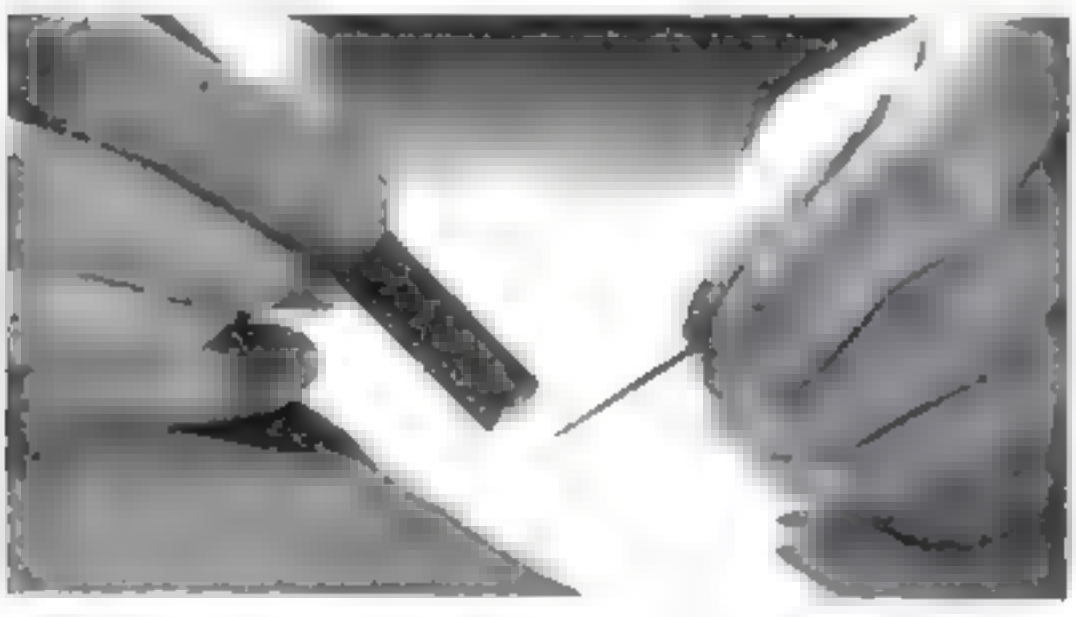
HOME EXPERIMENTS—EARTH'S

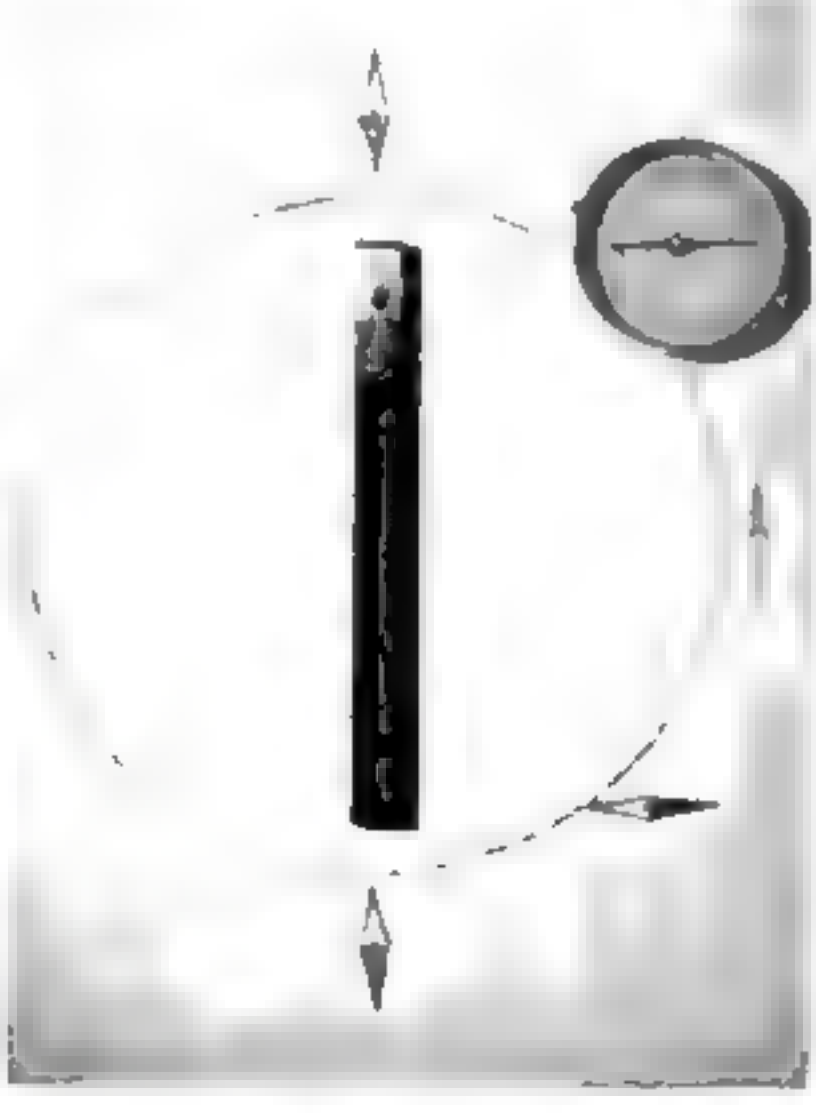
MAGNETISM was first observed as a property of certain iron ores that attracted iron and steel. The term is derived from Magnesia, the country in Asia Minor where the ores were discovered. In the Middle Ages, mariners discovered that a magnet which is floated on a chip of wood in water will be oriented in relation to the earth, since the earth is itself a gigantic magnet. Because only unlike poles attract each other, the earth's north magnetic pole, which draws the north-seeking end of a compass, is from the standpoint of magnetism a south pole. Many aspects of the fascinating subject of magnetism can be investigated with simple equipment in your own home.

MAGNETITE, OR MAGNETIC IRON OXIDE, is the lodestone of the mariners—the strange mineral that attracted man's attention to the whole subject of magnetism. That it exerts a definite magnetic attraction may be proved as shown above. The needles in compasses that are placed near it will be pulled out of line; iron filings will cling to its surface.

SOME COMPASS NEEDLES, called dipping needles, are pivoted to swing in a vertical plane. They are used to determine latitude. If one is placed near the earth's north magnetic pole, it will assume a vertical position with its north-seeking pole downward. If it is moved away from the north pole, it will rotate toward a horizontal position until, at the equator, it is horizontal. Continuing southward, it will keep rotating until, at the south pole, it is once more perpendicular, but now with its north-seeking pole skyward. To prove this to yourself, draw a circle, as shown below, representing the earth. Place a bar magnet within the circle with the magnet's south pole at the earth's north pole. Move a compass from place to place around the edge of the earth and note how the needle rotates.

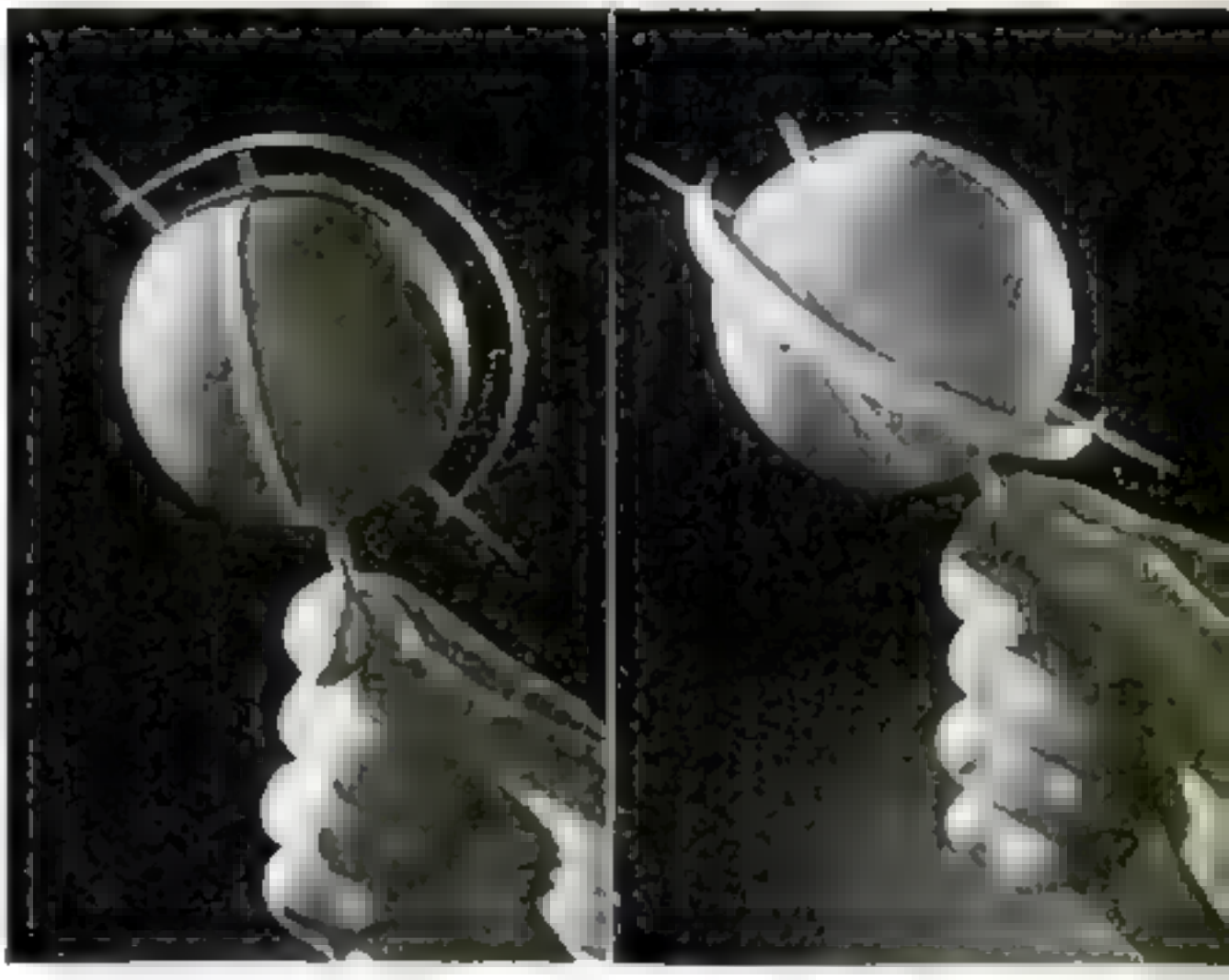
TO MAKE A COMPASS that is as good as the best that was known for centuries, use a small bar magnet, a needle, and a bit of cork. Stroke the needle across the south pole of the magnet, starting at the eye and ending at the point The polarity at the point will be opposite to that of the magnet. Put the needle on the cork and float it in water. The cork will revolve until the needle points to the north.





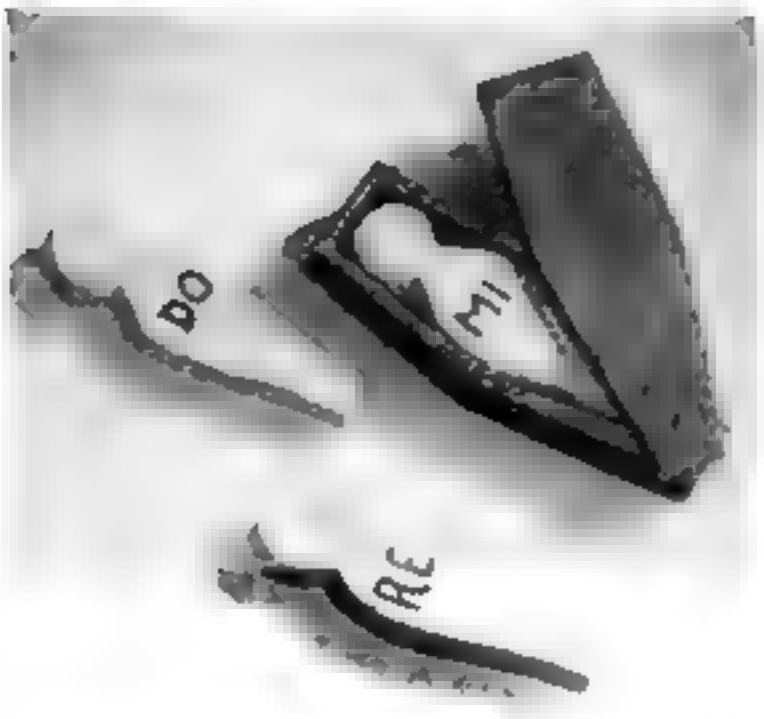
MAGNETISM AND THE COMPASS

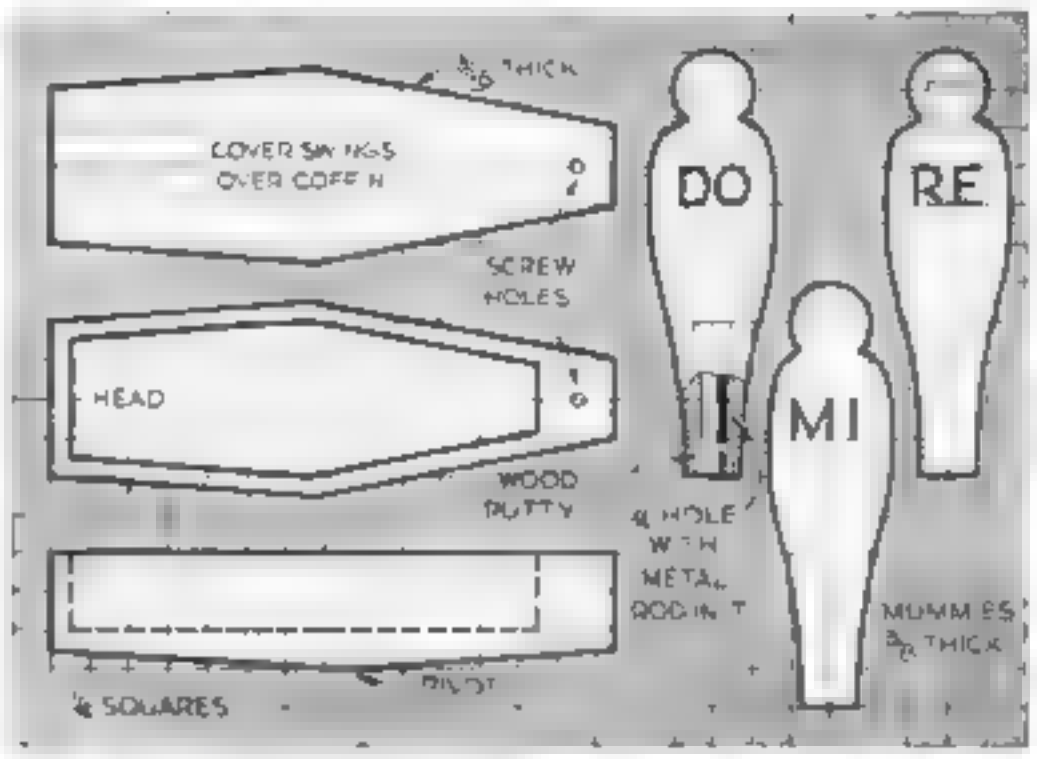
COMPASS VARIATION, the fact that at most places on earth a compass does not point true north, results because the earth's magnetic poles do not coincide with its axis poles. Actually they are more than 1,000 miles apart. By constructing a simple model of the earth, using an orange, a stick, two toothpicks, and three paper strips, as shown, you may readily see the compass needle's variation from the true north and south at various points on the earth's surface. The paper strip connecting the toothpick magnetic poles and the strips connecting the true axis poles can coincide in but two positions.



HERE IS A COMPASS made as described on the preceding page. The cork and needle are floating in a cup of water. Do not use a steel or an iron pan; instead, use a china or a glass vessel. If magnetized correctly, the needle point will turn to the north magnetic pole of the earth. No matter how often you swing it away, it will resume the same position. This improvised compass may be used, instead of a manufactured one, for some of the experiments that are described on this and the facing page.

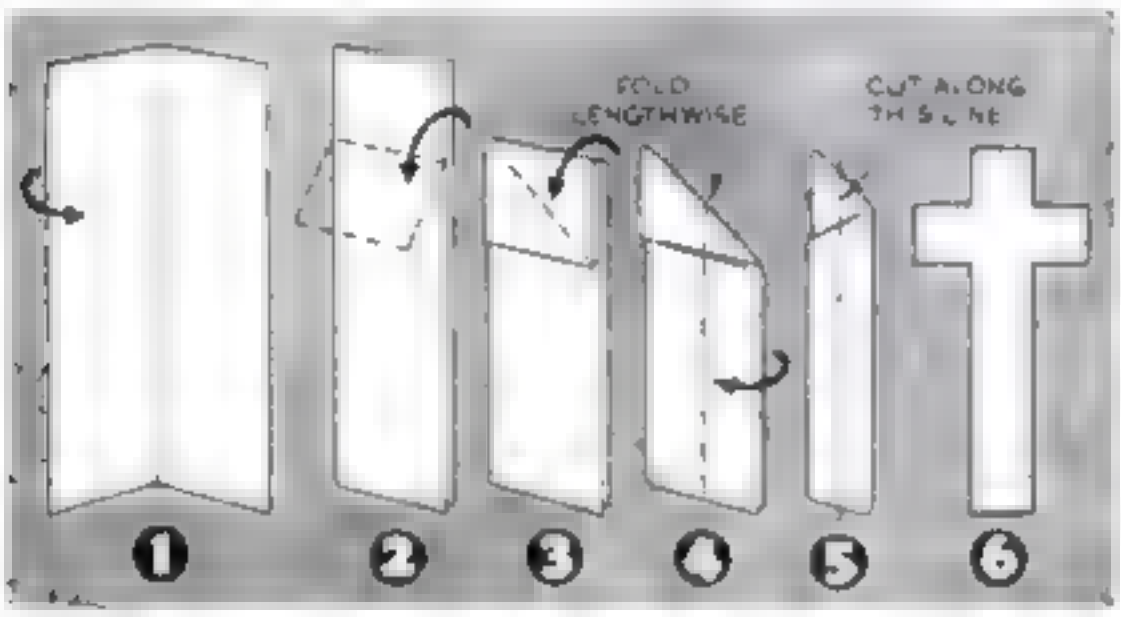
MAGNETISM OF THE EARTH can be demonstrated with an iron rod, a compass, and a hammer. Hold the rod north and south and tilt it down toward the north at an angle of 65 to 75 deg. Now tap the upper end with a hammer. Test both ends by bringing them alternately near one end of the compass needle. The rod will have polarity. Reverse the rod and tap it. The polarity will be reversed. Hold the rod east and west and tap it. It will lose its magnetism. Tapping the rod redistributes the molecules in accordance with the earth's magnetic field.





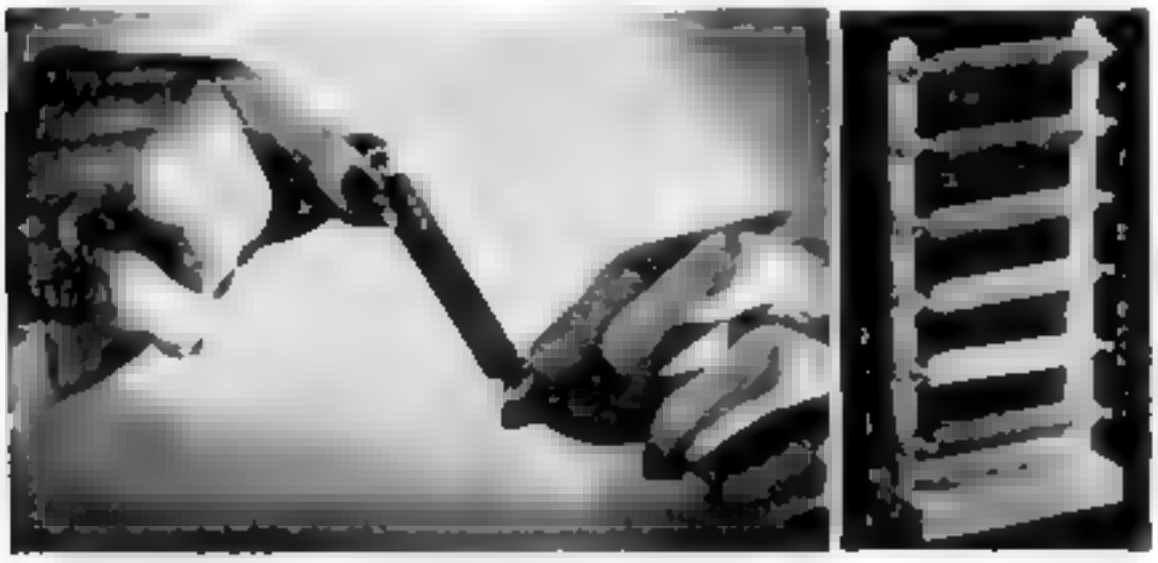
NAMING THE UNSEEN is always a good trick, and an entertaining variation is done with Do, Re, and Mi—three toy mummies that look exactly alike. Have one of them placed within a small covered coffin when your back is turned. Then about face, and name the mummy that has been concealed. Your clue is simple. Do is weighted at his head, Re at his feet, and Mi is not weighted at all. The bottom surface of the coffin is planed slightly at both ends, leaving about $\frac{1}{4}$" as a level spot at the center. Thus, the balance of the coffin reveals the identity of the mummy within

The figures are carved from wood $\frac{3}{8}$" thick, and fit into a coffin chiseled out to a depth of $\frac{1}{2}$". Iron rods cut from bolts serve as weights. They must be concealed carefully. Wedge them in tightly with toothpicks, putty the holes, and paint over them.



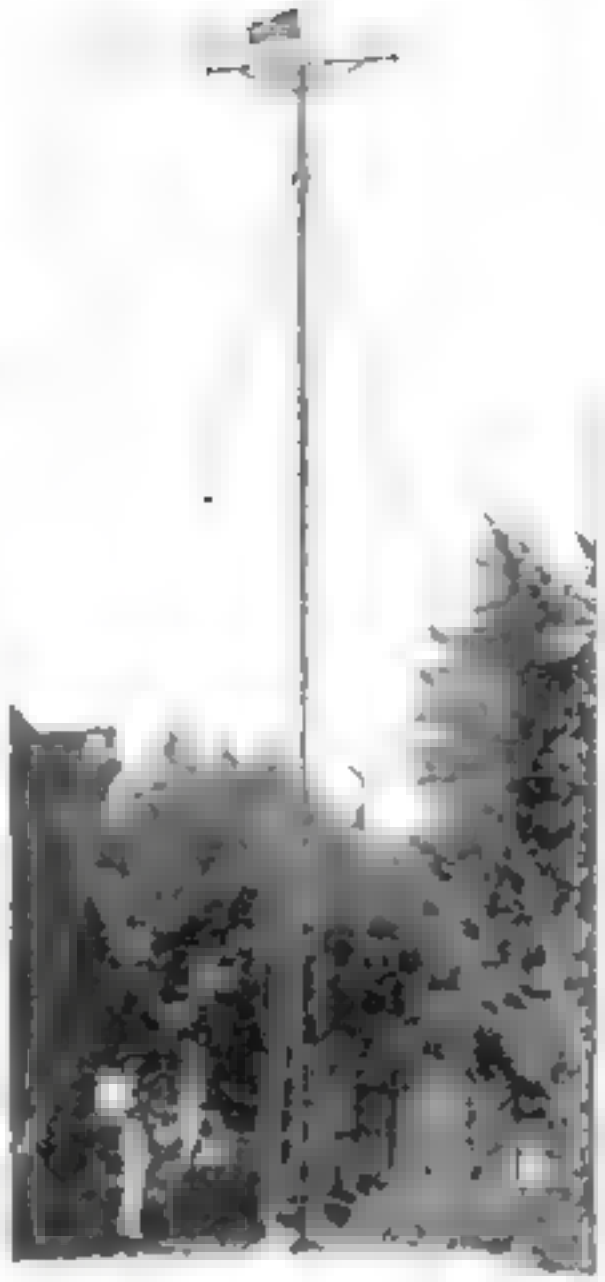
CHALLENGE YOUR FRIENDS to cut a cross from a piece of paper with one slice of the shears—then show them how it's done. Success of the stunt depends on two things: the shape of the paper and the way it is folded. Use a piece about twice as long as it is wide, and fold it as shown in the four steps at the left. When the paper has assumed the shape that is seen in view No. 5, cut it lengthwise through the middle.

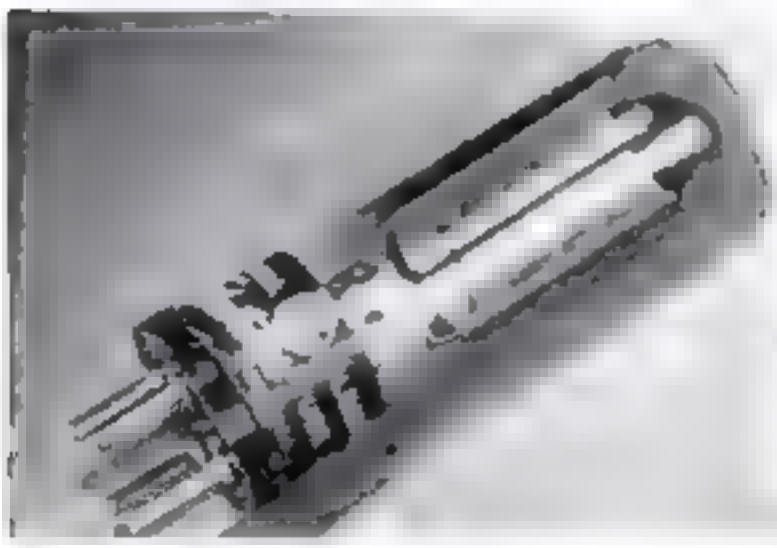
DIFFERENTLY COLORED DOWELS hung on a wooden rack are simple enough equipment for a really fine trick. When performing, hold your hands behind you. Have some one give you one of the dowels, the object being for you to name its color. Of course, the dowels look and feel just alike. However, the screw eyes at either end are attached differently. Some are screwed in with wax and turn easily, some are hand tight, others are glued in place and won't turn at all. You must work out a combination for each color and memorize it. For example, the red dowel may have one hand-tight and one fixed screw eye. Use $\frac{3}{8}$" dowels and $\frac{1}{4}$" screw eyes. Hang them on toothpicks inserted $\frac{3}{4}$" apart on the uprights of the rack.

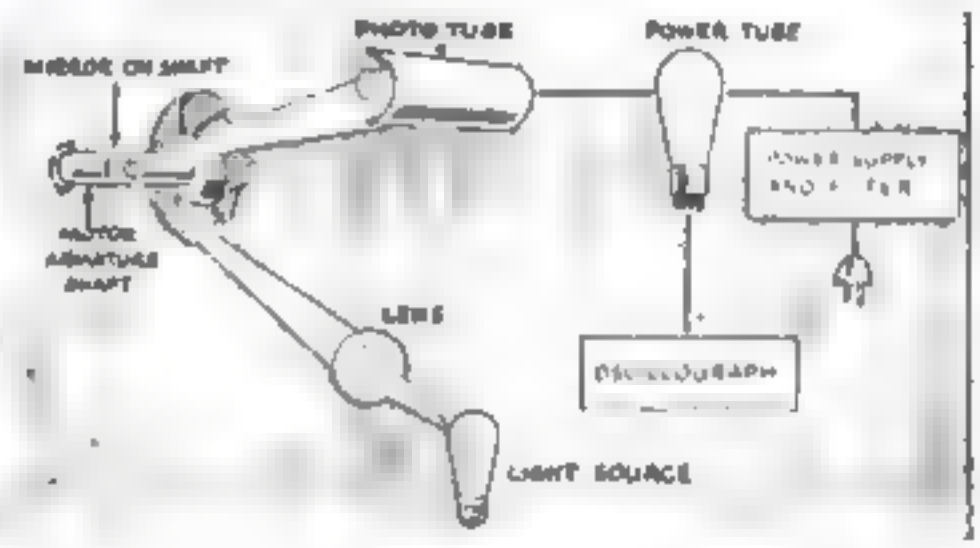


radio ideas

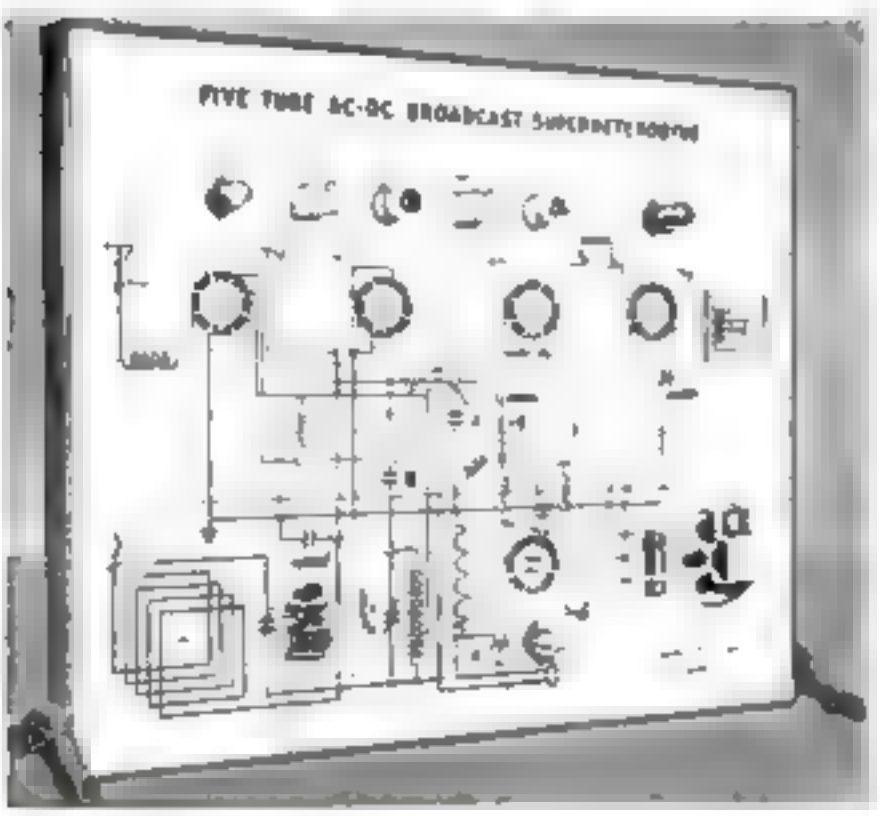
TUBULAR-PLYWOOD RADIO MASTS designed by the U. S. Army Signal Corps are among the first equipment flown onto captured airfields. These 4" diameter masts, much lighter than solid wood or metal, are 50' and 75 in height and consist of several 11' sections plus a top section slightly under 5'. The tubes are thin hardwood veneers welded with plastics into ⅜" thick walls. They are assembled on the ground with plywood couplings, set into a hinged metal socket, and raised by a boom. Once erected, a mast is braced by guy wires held by long pegs in firm ground or spiral pegs in loose soil



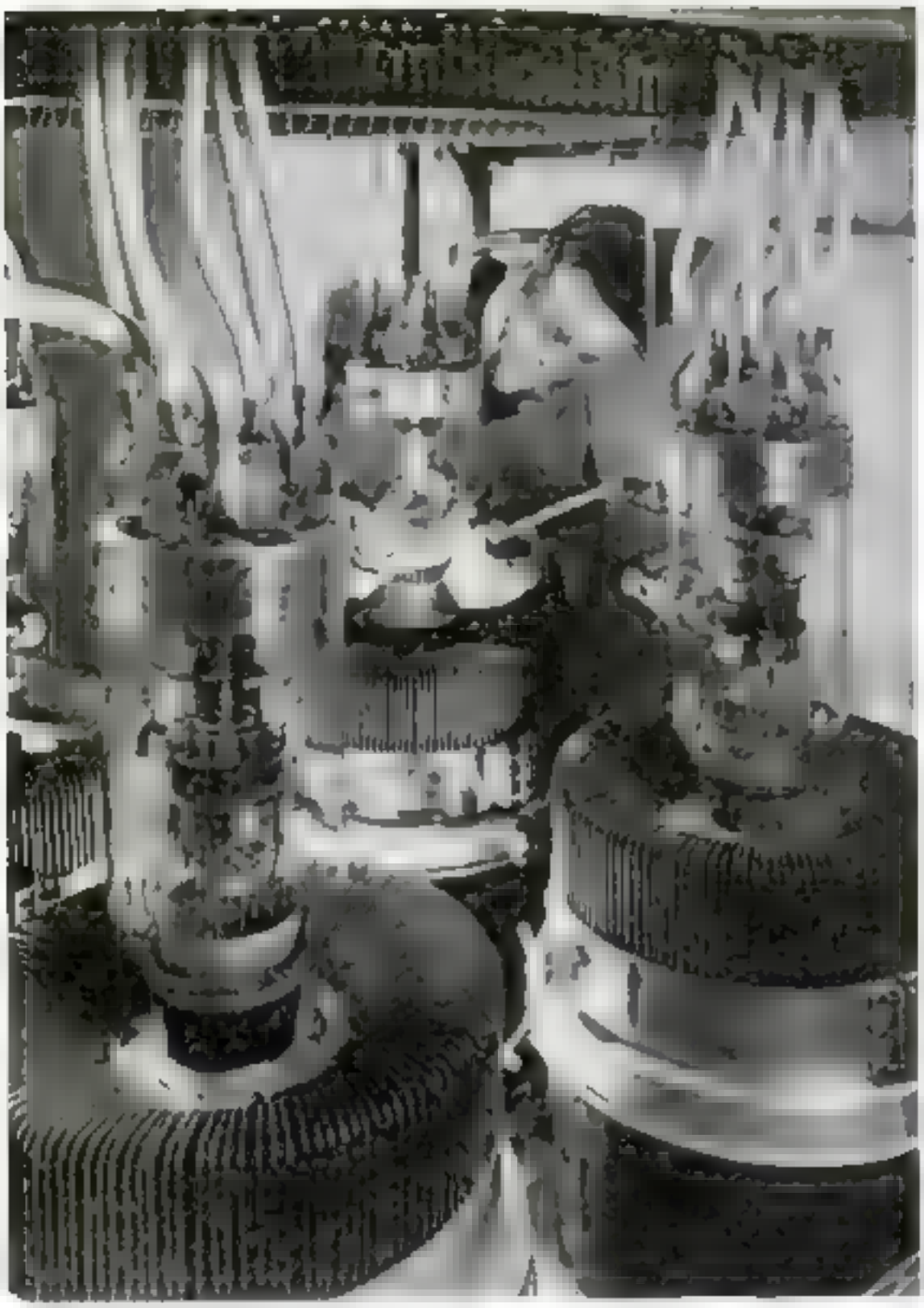




COUNTING REVOLUTIONS a motor armature makes after current has been cut off and a brake applied has been accomplished with an electronic phototube connected with an oscillograph galvanometer. In the experiment, conducted at the Bridgeport Works Laboratory of the General Electric Company, a tiny mirror was glued to the armature shaft to reflect a beam at each revolution. The galvanometer deflections are recorded on film and can be counted. Each represents one shaft revolution



THIS DEMONSTRATOR PANEL is a schematic representation of a superheterodyne receiver and actually operates. The parts are mounted in view adjacent to their schematic positions on the panel. Multiple snap connectors permit opening of each coil, condenser, or resistor to simulate actual conditions in defective receivers. Circuits are in four colors for easy tracing. The panel was developed by the Lafayette Radio Corporation, of Chicago.



Each of these air-cooled modulator tubes has a 50,000-watt output

GIVING

How Sounds Picked Up by the Microphone Are Impressed Upon the Space-Spanning Carrier Waves That Made Radio Possible

By JOHN W. CAMPBELL, JR.

WITHOUT modulation—the process of impressing meaningful variations on a carrier wave—we might still be in the days of wireless telegraphy. High-frequency radiations have the peculiar property of spanning space without conventional electrical conductors. By themselves, however, they have only a limited communications value; they can send a signal by what might be called the turn-it-on, turn-it-off method, that is, by code. Even this, as shown in the drawing on the facing page, is an elementary form of modulation.

To give radio a real voice, engineers have ingeniously combined two forms of electricity into a hybrid. Since the early days of the telephone, it has been possible to translate sounds into varying electrical currents, send them along wires, and then retranslate these currents into sounds. What modulation does is to superimpose on the space-spanning R. F. waves the complex patterns of sound-giving A.F. waves. One kind of wave travels without wires but of itself carries no meaning, the other reproduces sounds but ordinarily requires wires—and together they make radio possible.

The current passing through a microphone, though constantly varying in strength, is not discontinuous. The R.F. carrier wave therefore can't be interrupted; instead it must be varied in exact accordance with the A.F. impulses that represent speech and music. Fig. 1 shows how this is done by amplitude modulation. The carrier wave has a constant frequency, but its amplitude is varied from instant to instant by the A.F. signal. What appears as the outline of the wave form is an accurate representation of the impressed audio frequency. Another method, frequency modulation, is shown diagrammatically in Fig. 2. Here there is no variation in the amplitude (strength) of the carrier wave; instead, the message-carrying changes are in the frequency of the R.F. signal.

In a vacuum tube a small change in grid voltage causes a great change in plate output, so that modulating a transmitter might seem to be a simple matter. All that would apparently be necessary would be to feed A.F. signals from the microphone to the grid of an R.F. amplifier tube. Actually, this would be an extremely inefficient way to design a transmitter. To understand why this is so, it is necessary to examine for a moment the kinds of transmitter amplifiers commonly used, and their special characteristics.

Vacuum-tube amplifiers may be of several

RADIO ITS VOICE

different types, of which the commonest are designated Classes A, B, and C. Figure 4 shows the sine wave and circuit of Class A amplification, as achieved by two tubes arranged in push-pull.

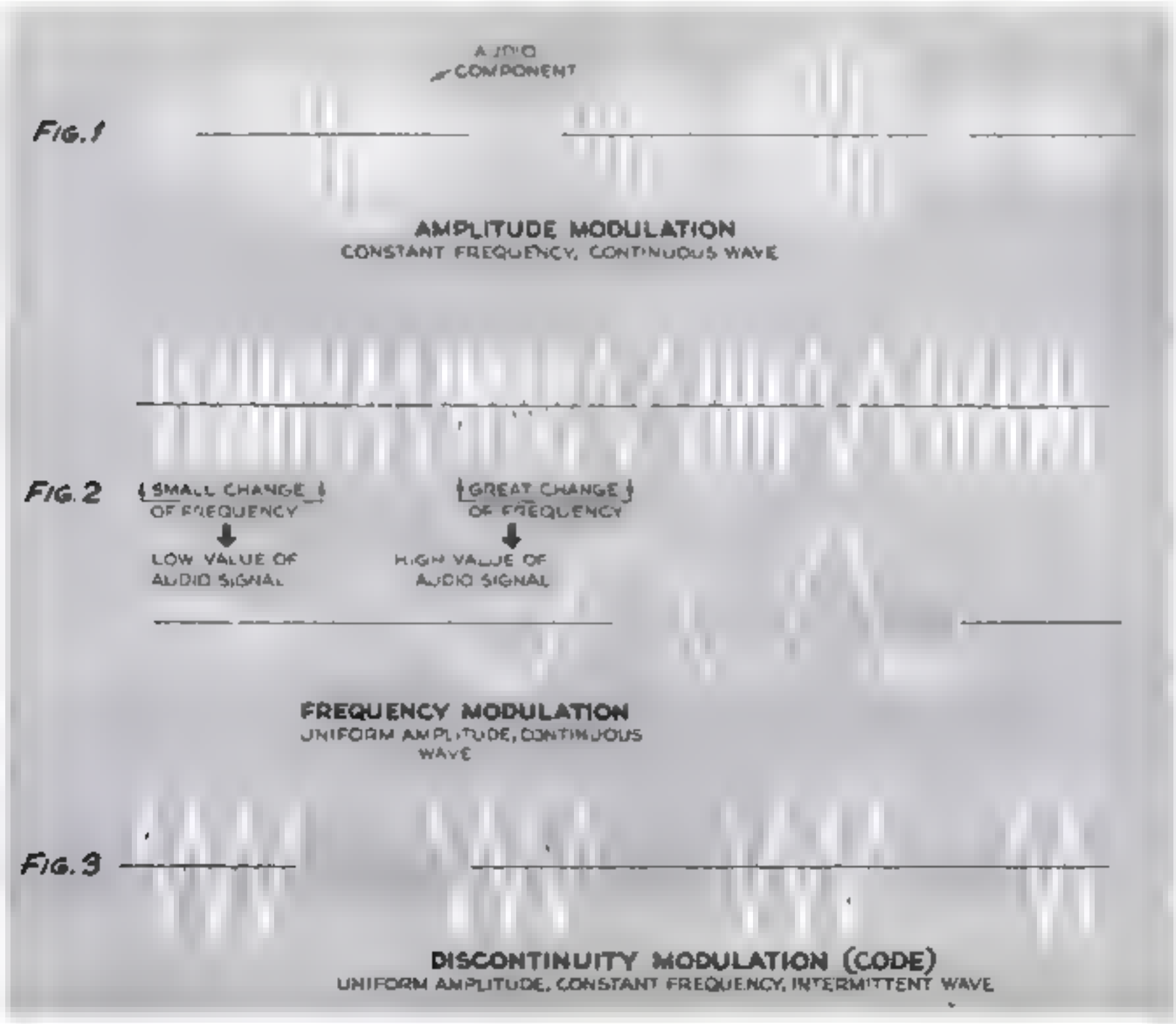
The latter term, incidentally, describes a method of pairing tubes to produce approximately twice the maximum plate-current swing that either could produce by itself. Push-pull is a useful arrangement—frequently it is the *swing* of plate current, not its amount, which is valuable—and it is often employed in Class A, and always in Classes B and C.

Returning to Fig. 4, it can be seen that there are several important characteristics of Class A amplification. One is that the grid draws no actual current from preceding stages; it requires only a potential, or voltage. The second is that the grid signal may not exceed the grid bias without causing distortion. And the third characteristic is that a substantial plate current passes even when no signal is impressed on the grid.

Because of this last fact, Class A does not afford the maximum swing of which the tube or tubes are capable. A greater range between the no-signal current and the maximum-signal current can be obtained by applying so much grid bias that the tube passes almost no current when no signal is present, and by permitting the signal to exceed the grid bias. The result is Class B amplification (Fig. 5).

In Class B the grid draws current when the signal voltage exceeds the bias, and one or the other of the tubes (Class B is used only in push-pull) is always conducting. The circuit is so arranged that the signal voltage is inverted before reaching one of the tubes; after one tube follows its half of the signal and then cuts off, the other begins conducting. Class B uses tubes far more efficiently than Class A; a pair of 6L6's, for instance, will yield about 55 watts of audio power in Class B, compared to about 30 watts in Class A.

Class C amplification (Fig. 6) carries the same idea a step farther. Here the grid bias is made nearly twice the value necessary to cut off the plate current, and a grid signal which is twice *that* value is applied. The



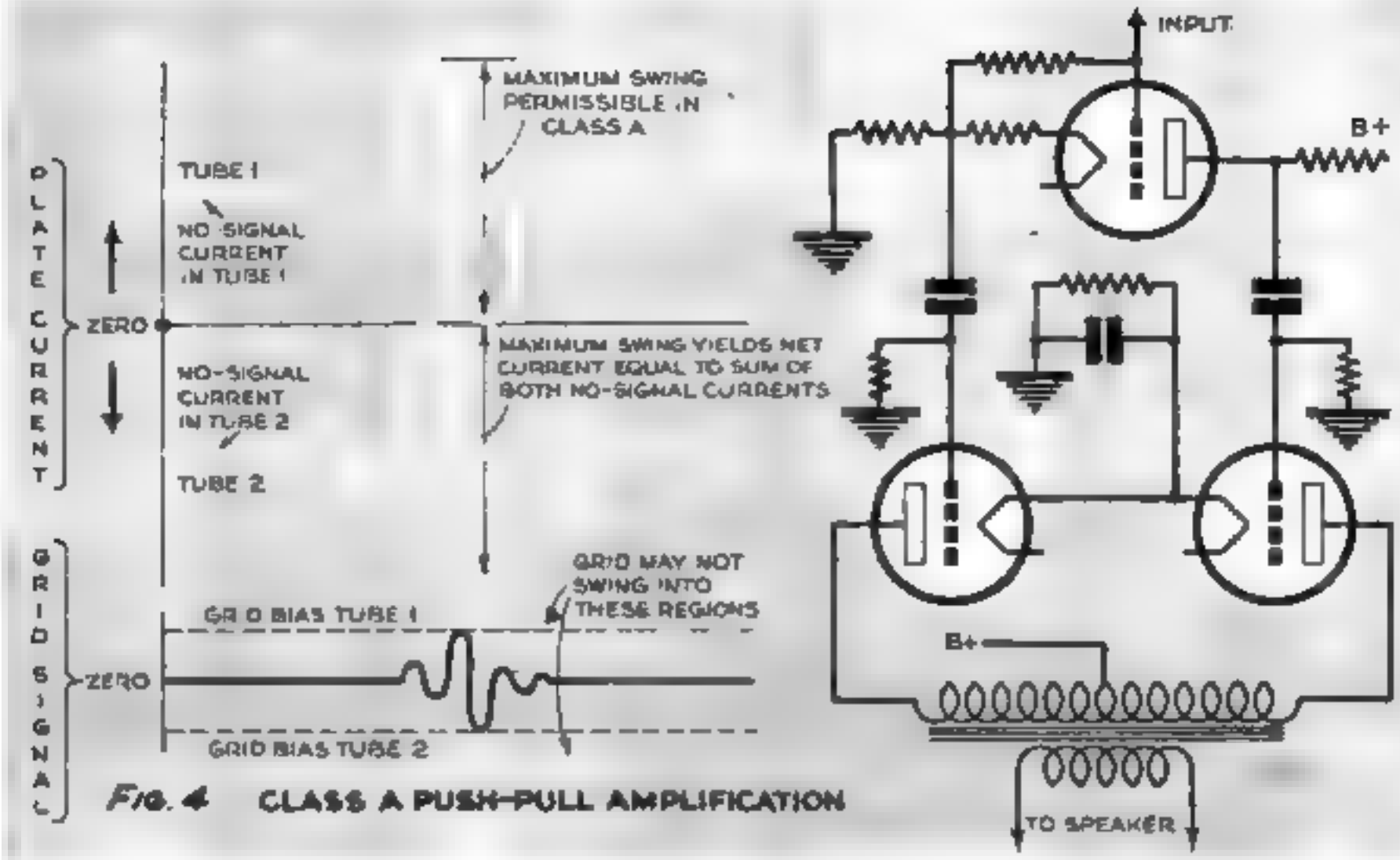
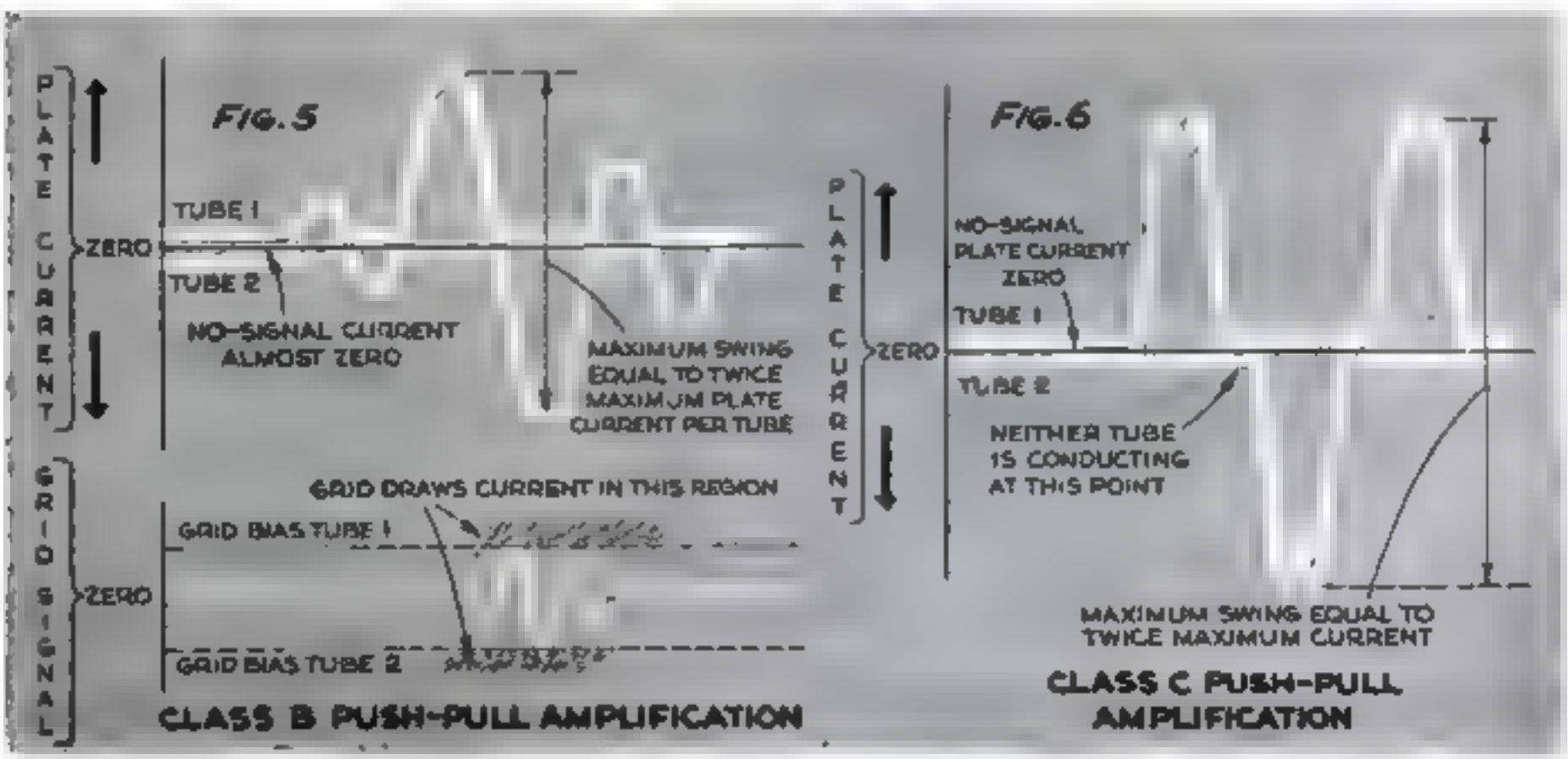


FIG. 4 CLASS A PUSH-PULL AMPLIFICATION

grid is driven so far positive that every electron the cathode can release is sucked across the tube. In fact, at the peak of the signal, plate current is actually decreased for an instant because the highly positive grid absorbs a respectable fraction of the electrons emitted by the cathode.

Class C amplifiers produce a very ragged output because of this dip in plate current, and because, due to the high grid bias, the plate current is wholly cut off in both tubes during an appreciable part of the cycle. Although Class C is the most efficient method of power amplification in use—the pair of 6L6's already mentioned would give over 90 watts of R.F. output—its raggedness limits it to R.F. amplifiers in transmitters, where the resonant tank circuit, like the flywheel of a one-cylinder gas engine, helps smooth out the periodic surges of energy.

Earlier, it was mentioned that the most obvious way to modulate a transmitter would seem to be to apply the signal to the grid of an R.F. amplifier tube. The reason why this isn't done is now apparent: the output of Class C is so rough that the transmitted signal would be badly distorted. Yet a transmitter in which modulation could be applied at the grid isn't the answer, since it would require for undistorted output the use



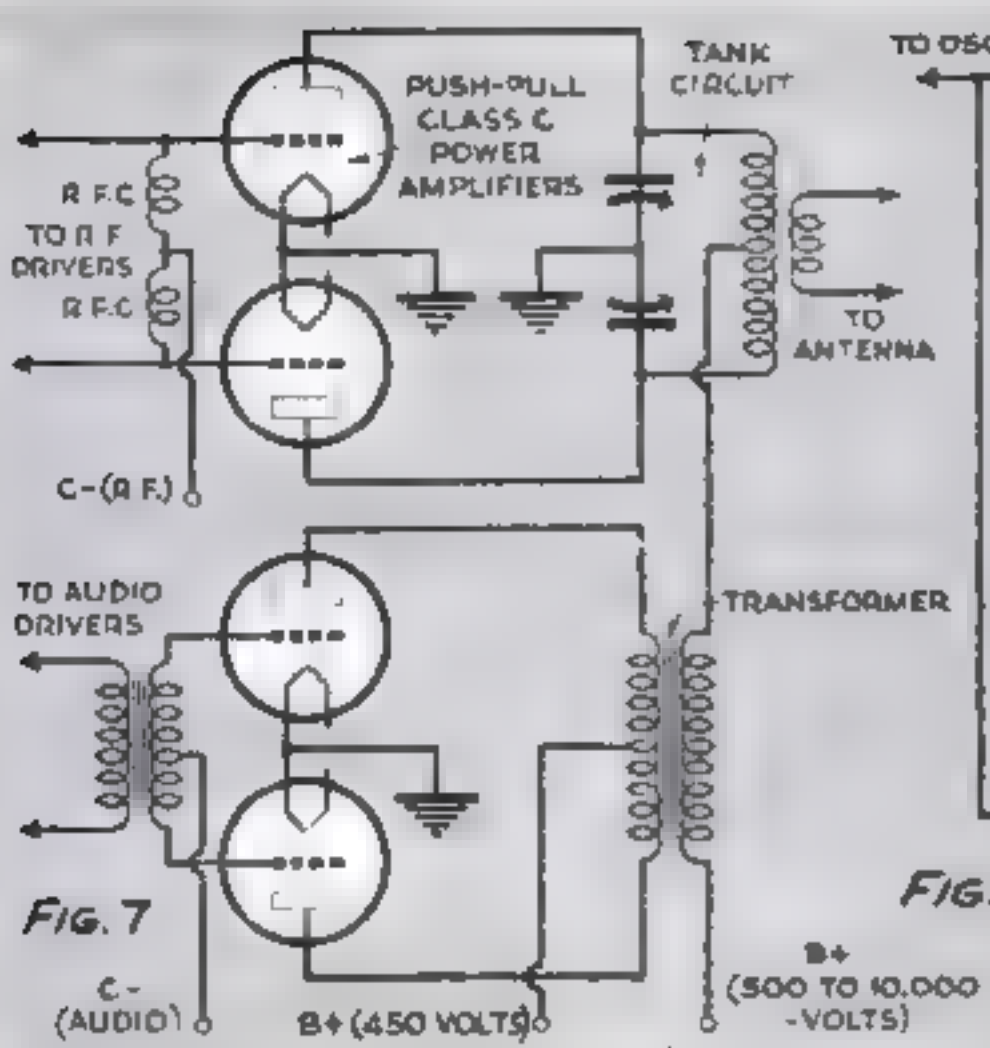


FIG. 7

PLATE MODULATION (A.M.)

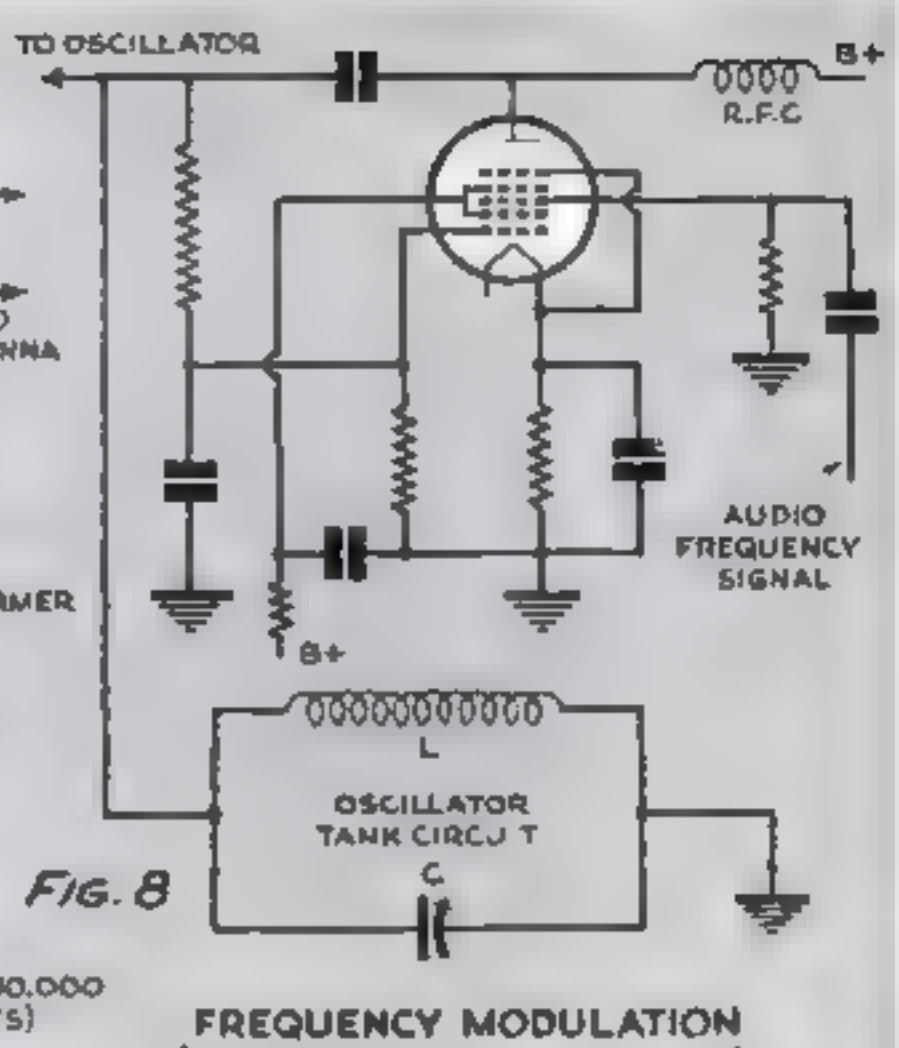


FIG. 8

FREQUENCY MODULATION (REACTANCE MODULATOR)

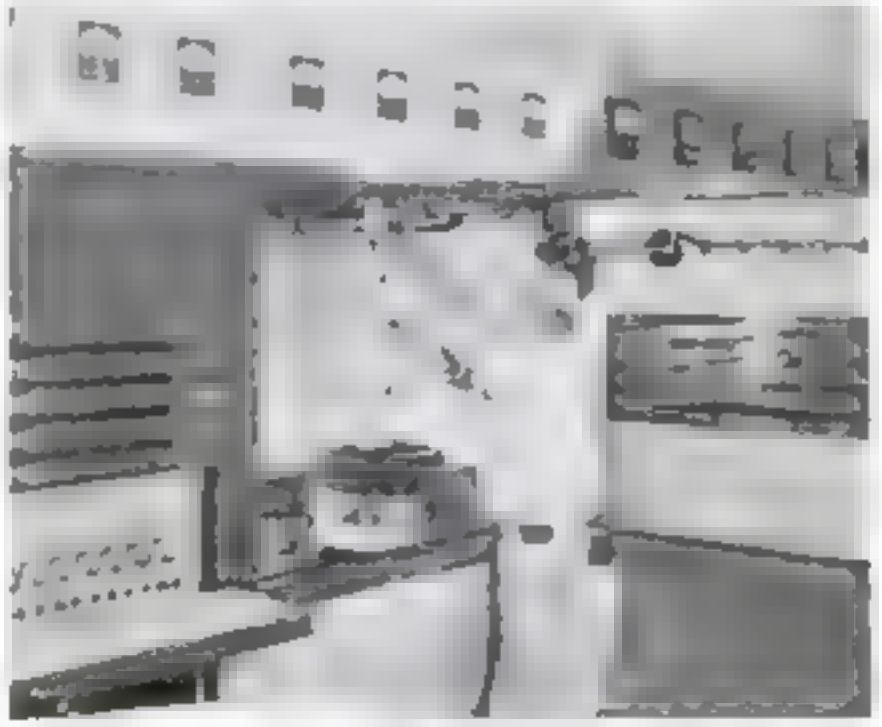
of Class A or at best Class B amplifiers in R.F. stages—an uneconomical way to obtain a powerful carrier wave.

Fortunately, the output of a tube can be varied by controlling any of the electrode voltages—grid, cathode, or plate. In most amplitude-modulation transmitters, accordingly, the A.F. is impressed on the plate of the final Class C amplifier. It is not affected by the tank circuit employed to smooth out the Class C output, since A.F. is unchanged in a circuit resonant at radio frequencies. From the viewpoint of power required, modulation at the plate is a far cry from grid control. It takes about half as much as the actual output itself to modulate a transmitter in this manner—say, 25,000 watts of A.F. energy to modulate a 50,000-watt R.F. output. The extra power required for modulation at the plate is not wasted, since in actual practice it adds to the strength of the carrier wave.

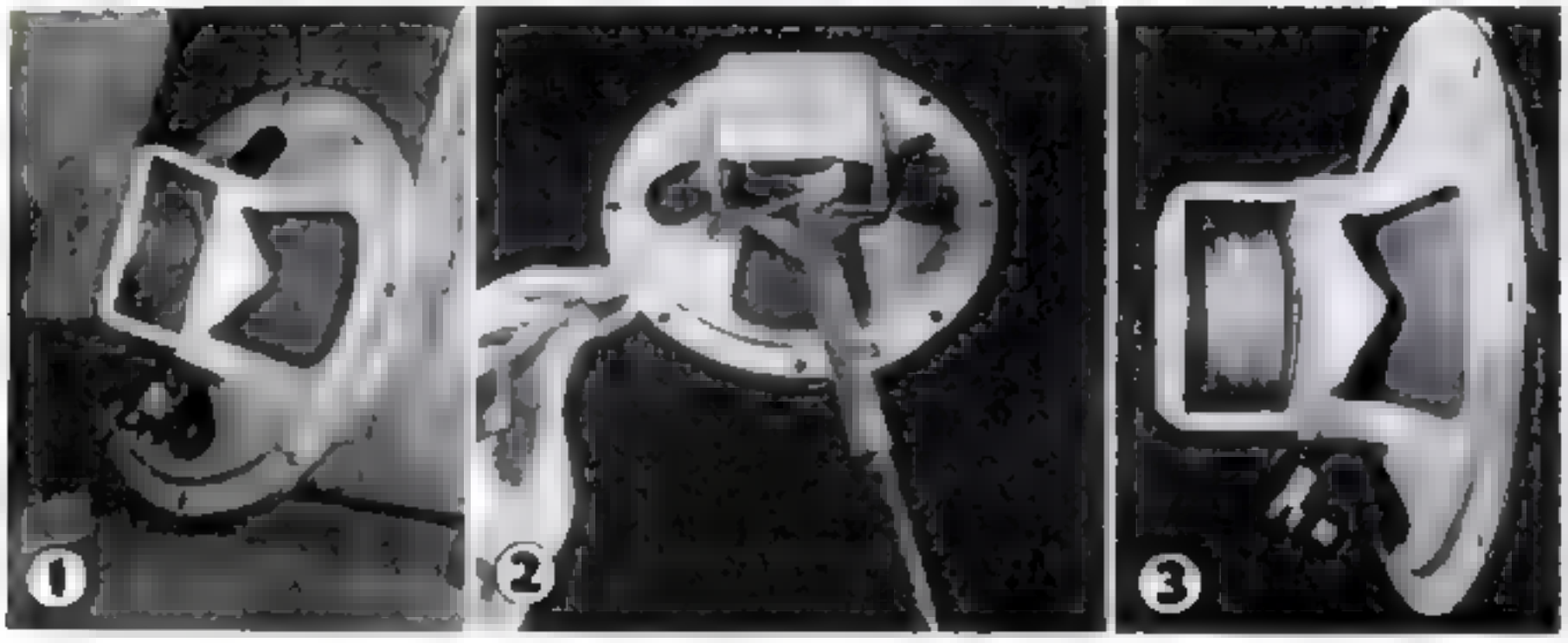
Frequency modulation is a different and in some ways a simpler matter. The A.F. impulses are applied to the original oscillator that generates the radio frequency, and only a small amount of power is required. (The reason A.F. can be applied at this point, rather than on the plate of the final Class C amplifier, is that the amplitude does not have to be changed, but only the frequency.)

Two principles are ingeniously used in achieving frequency modulation. In a resonant circuit, the current in the inductance lags the voltage by 90 deg., and a vacuum tube coupled to the circuit is also capable of producing a current that lags the voltage by 90 deg. The tube can therefore act in the tuned circuit exactly as an inductance would. In practice, a polygrid tube is used, with the lagging current established by the first grid and the amplitude of the current controlled by the second. Thus if A.F. is fed to the second grid, the amount of lagging current varies with the audio signal. Since the effect in the tuned circuit is as though the inductance were being varied, the oscillator frequency will faithfully follow the audio signal.

In big transmitters the modulating unit is highly important to signal quality. Below, an air-cooled modulator tube of new design is installed in KDKA



ELIMINATING SPEAKER HUM



Servicing Your Radio

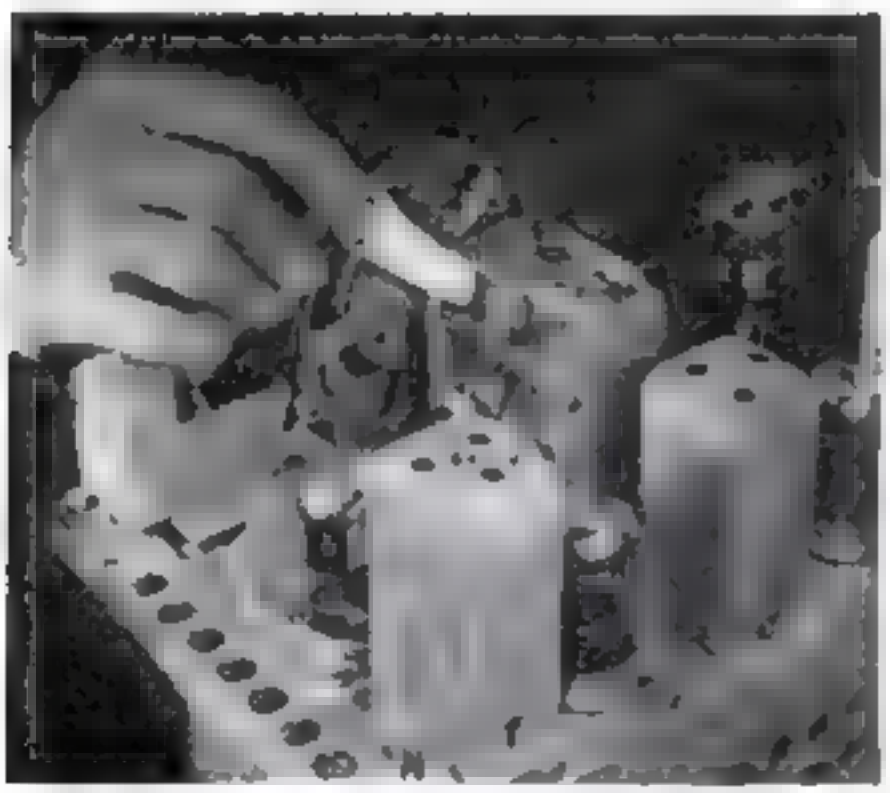
RESIDUAL or "field" hum in a small speaker is caused by ripple voltage on the field winding. In an automobile receiver it comes from the transients on the field-supply line caused by the vibrator in the power supply. This hum cannot be filtered, and although in some cases it may be possible to readjust the "hum-bucking" coil that is wired in series with the voice coil, it may be more convenient to smooth the field ripple in the following manner:

Wind a number of turns of heavy, tinned wire about the field coil. The size of the wire is not important except that it should be as large as is convenient to handle. Put on as many turns as possible, being careful not to break through the paper insulation that covers the field coil, as this may cause a field short. It is not necessary to insulate the auxiliary coil from the frame of the speaker (Fig. 1). Solder the turns together, as shown in Fig. 2, thus creating an effective single shorted turn (Fig. 3).

This shorted turn acts as a shading ring, which decreases the inductance of the field while increasing its reluctance. It behaves similarly to a shorted turn in a power transformer and tends to resist the collapse of a magnetic field as the ripple current passes through a cycle. This maintenance of a constant field will reduce ripple hum, and the lower the resistance of the shorted turn, the less the fluctuation of the field current will be observed.

The method is not a cure-all, nor a substitute for filtering. Although it works on an automobile speaker as well as on a home set, the effect is more noticeable on the bench than when the speaker is back in the car.—GEORGE O. SMITH

Homemade Tuning Wand Helps in Aligning Receiver Oscillator

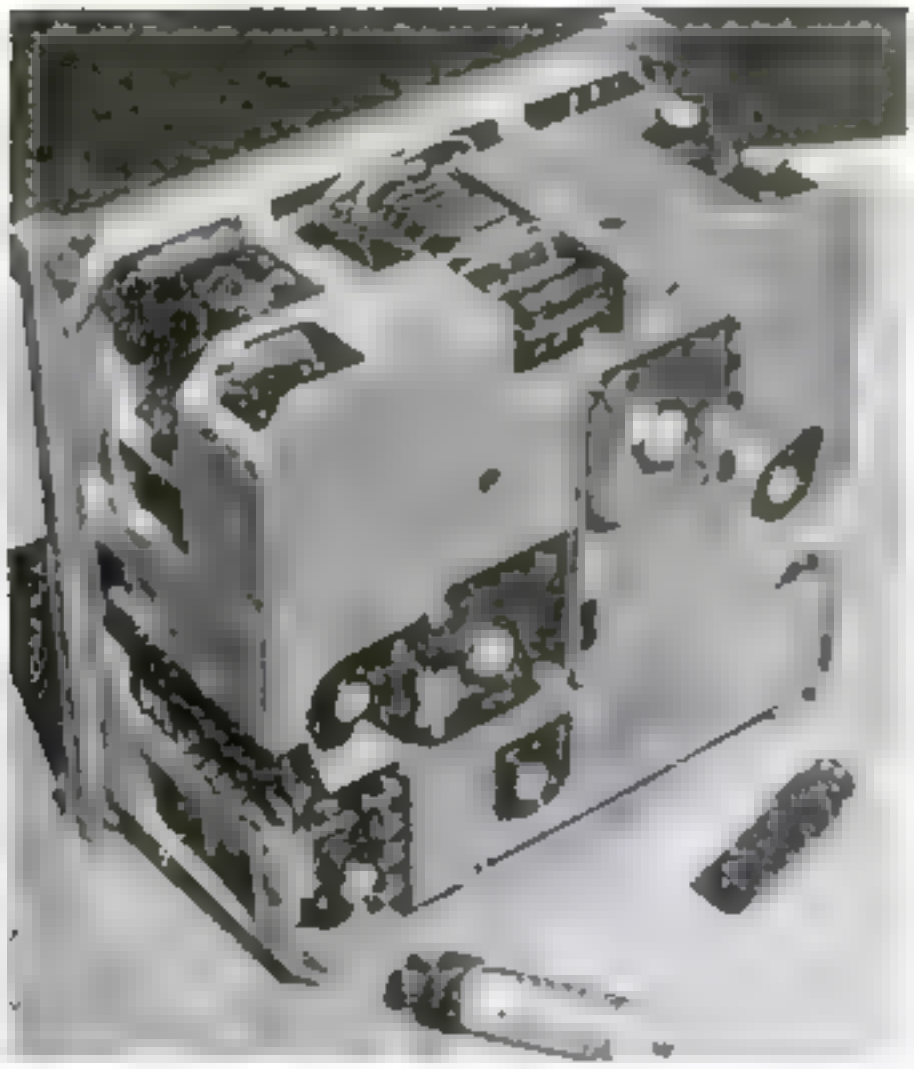


IN RECEIVERS where the oscillator and R.F. coils are not readily accessible for inserting a tuning wand, a strip of photographic film, old pyralin dial, celluloid, or similar material will serve handily. It should be thin enough to pass between rotor and stator plates without bending them.

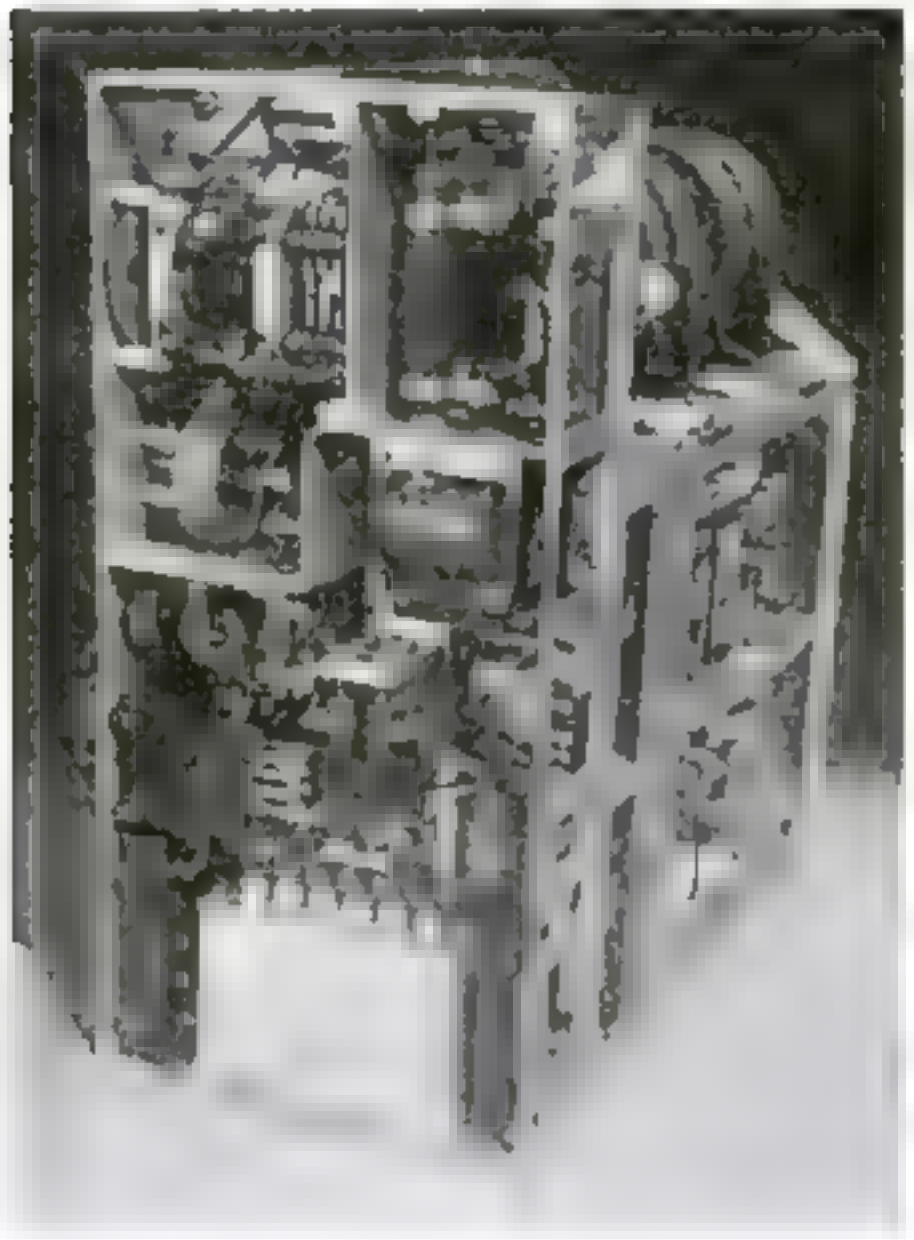
When alignment is considered good, insert the strip between the plates of the antenna and R.F. section. If response increases, the antenna and R.F. tuning is high, and the padding condenser should be decreased. Should response fall off immediately, insert ¼" of the strip in the oscillator section and turn the gang condenser to full resonance. If this gives more output, the oscillator tuning is high, and the padder should be increased slightly.—G. O. S.

Is Enemy Radio Equal to Ours?

CAPTURED GERMAN SETS, THOUGH GOOD, ARE BEHIND OURS, WHILE JAP EQUIPMENT DATES BACK TO 1930



Above is a German superheterodyne tank receiver. It has a range of 27.2 to 33.4 megacycles, and uses a dynomotor that draws 4 amps. from a 12-volt battery



U. S. ARMY Signal Corps representatives have had the opportunity to study and test a wealth of captured German and Japanese radio equipment. The results of their investigations are of real interest to all radio listeners and especially to hams.

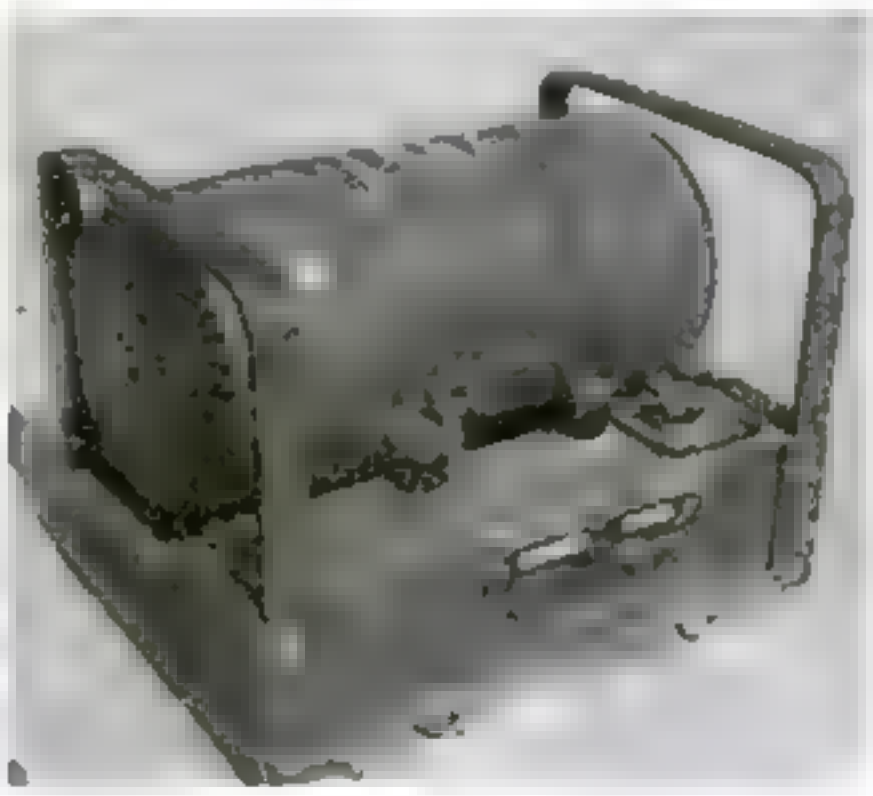
In general, they have found German sets to be five years behind our own and Japanese design and construction to be nearly 15 years old when judged by our own standards.

The German sets are well built, but lack waterproofing and dustproofing They suffer from obviously critical shortages of steel, copper, zinc, mica, quartz, and phenolic resin. Copper and copper alloys are used solely for contact springs, terminals, and other pieces in which low resistance is a prime requisite. When mica is used, it is usually brown and definitely of an inferior grade.

Despite the shortage of quartz, it is employed in an interesting manner in one German transmitter. This set has a frequency-calibration checking device that consists of a tiny bar of quartz in a gas-filled glass container. When the crystal is excited at its resonant frequency, the gas lights up. If this glow does not appear at a pre-established reference point,

German 5-watt tank transmitter. A self-excited oscillator with a single-tube final amplifier, operating on 12 volts with a drain of 7 2 amp.

Below, the German dynomotor that supplies power to the tank transmitter. It turns at 3 000 r.p.m.



the trimming condensers are manipulated until it does.

The shortage of phenolic resin is most apparent when laminated-plastic resistor and condenser mounting strips are used. Because the bond applied between the laminations is not waterproof, as is phenolic resin, the laminations separate when damp.

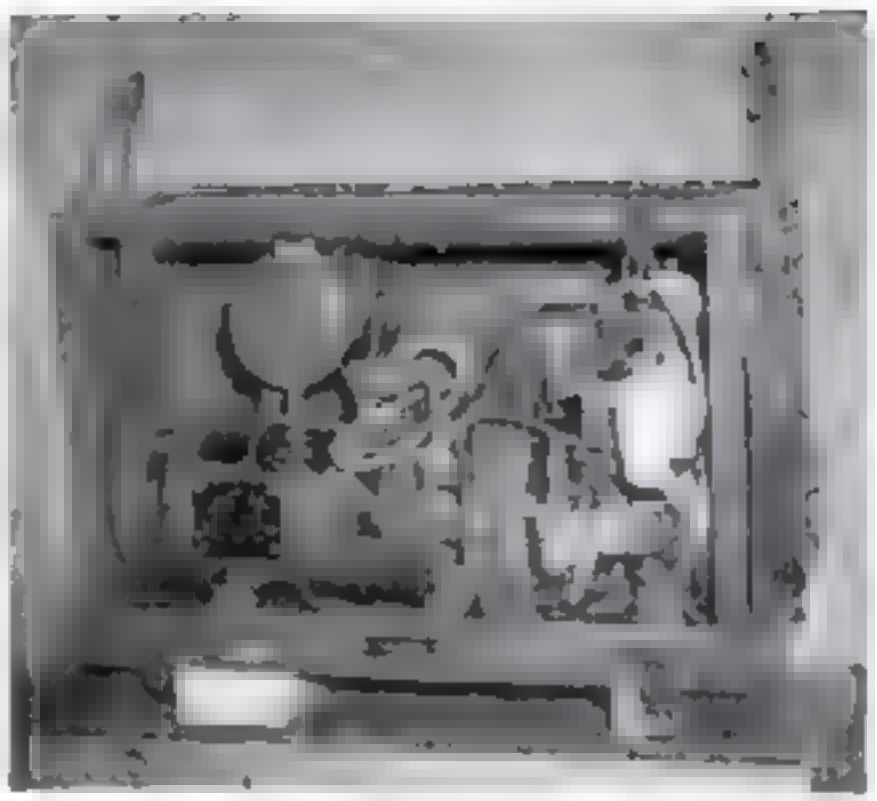
Aluminum and magnesium alloys, nickel, and tin are used extensively. Plywood and hard fiberboard, covered on both sides with thin sheets of metal, usually aluminum, are utilized for panels, side walls, and covers.

Instead of mica in ordinary condensers, a resin-impregnated paper is used; in compression-type trimming condensers, a silvered ceramic material is employed.

Tube shields are made of various materials. The best of them are constructed of extruded aluminum or hot-worked magnesium. Others consist of a molded substance on which a thin layer of metal has been sprayed. The worst-protected tubes have shields that are simply layers of metal sprayed directly on the tubes themselves.

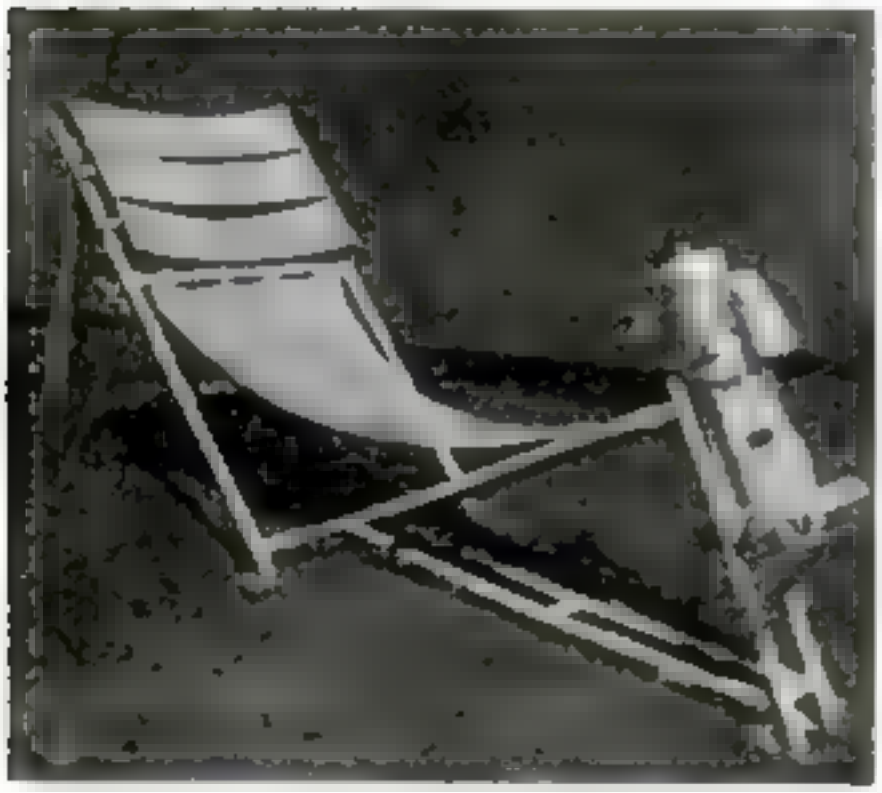
All the parts are marked with terminal numbers to facilitate replacement. The wiring is small and neatly cabled. Dials are well machined and accurate. There is little backlash. All the sets are designed for mass production.

Many of the parts used in Japanese sets are copies of equipment sold on the American distress markets back in 1930. Their nonwatertight cabinets have frames made of wood. The coil frames are also wood, or molded mud, even in equipment operating up to 90 megacycles. Most of the transformers are unpotted. Crystals, however, are usually well designed. They are accurately ground and are set in carefully molded holders. Nameplates are often made of sheet ivory with the lettering cut and blackened in the conventional manner.



Jap portable gasoline-engine power-supply unit. An exception to the usually poor Jap equipment, it weighs only 103 pounds and delivers 914 watts

Jap direction finder and intercept receiver. Range: 100 to 2,000 kc. Employing a heterodyne detector, three stages of R.F. amplification, and two stages of audio amplification, it is comparable to the American sets of the 1925 to 1930 period. The loop antenna consists of six unshielded turns and has approximately 16 sq. ft. of projected surface area



Italian pedal generator, called Lawn Chair Mark I by Americans. It is driven by two bicycle pedals while the operator reclines in the canvas chair

Starter Repair for Induction Motor

INDUCTION motors equipped with throw-out mechanisms of the type shown at the left will not start themselves when the two semicircular sliding plates become so badly worn that they no longer make contact with the split ring mounted on the end plate. Irregular starting may also show that the plates are worn

This can be remedied by removing the sliding plates and filing the bolt slots longer at the outer ends, as shown at the left below. It may be necessary also to file a little from the tips. In some cases, turning the plates over to utilize the unworn edges is desirable.—W. E. B.

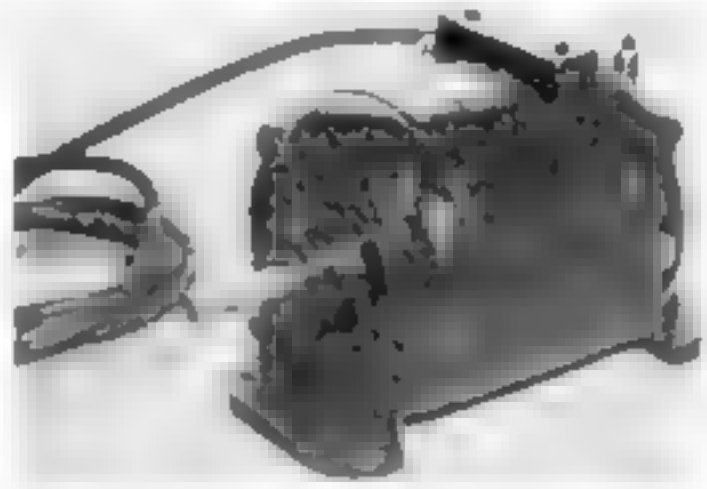
Nail Clippers Used in Stripping Wire

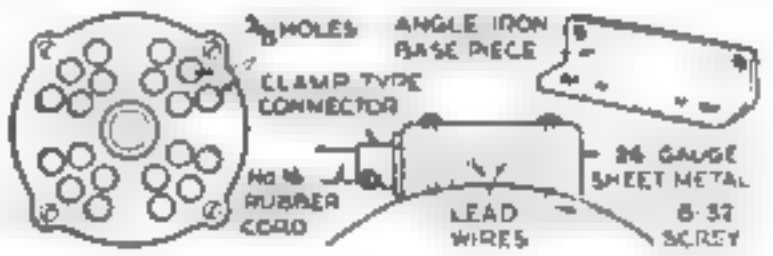
SMALL semicircular notches filed or ground in the jaws will convert a pair of discarded nail clippers into a handy tool for stripping insulated or enameled wire. Vary the size of the notches for wires of different gauge. Use care to avoid nicking the wire.

Pump Motor Adapted for Shop Use

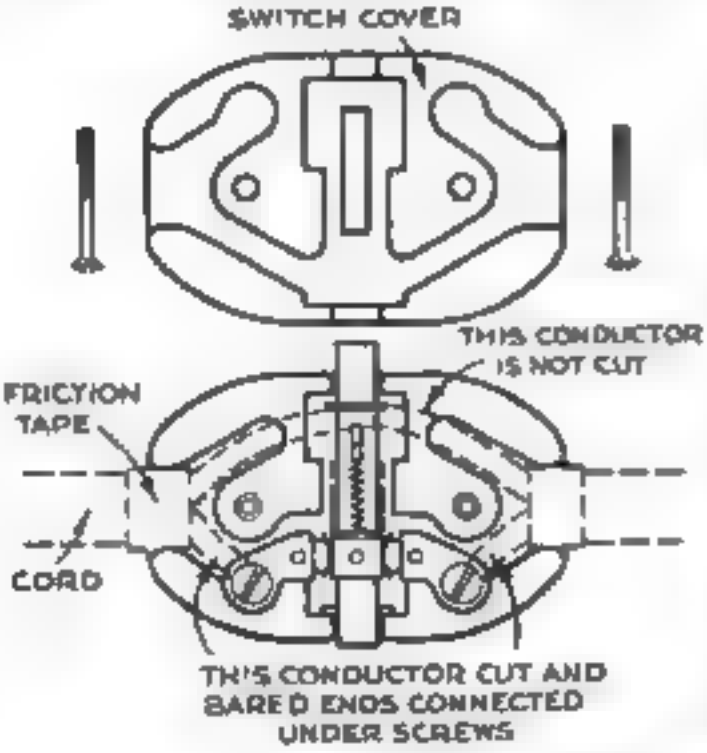
Motors of about 1/3 hp., designed to run on 115 or 230-volt single-phase A.C., can often be purchased from dealers in used gasoline-pump equipment. These motors are well built, but they require some simple conversion for shop use.

Start by taking such a motor apart and cleaning out all grease and dirt. Then drill several ⅝" holes in each end cap for ventilation. Repack ball bearings in fresh grease. For continuous operation, it is advisable to install an internal fan. Replace any badly worn wiring. A terminal box may be built from sheet metal. Solder and tape all joints in the box. A base that can be attached to a bench can be fashioned from heavy angle-iron stock.—HAROLD P. STRAND.





FEED-THROUGH CORD SWITCHES [ELECTRICAL]



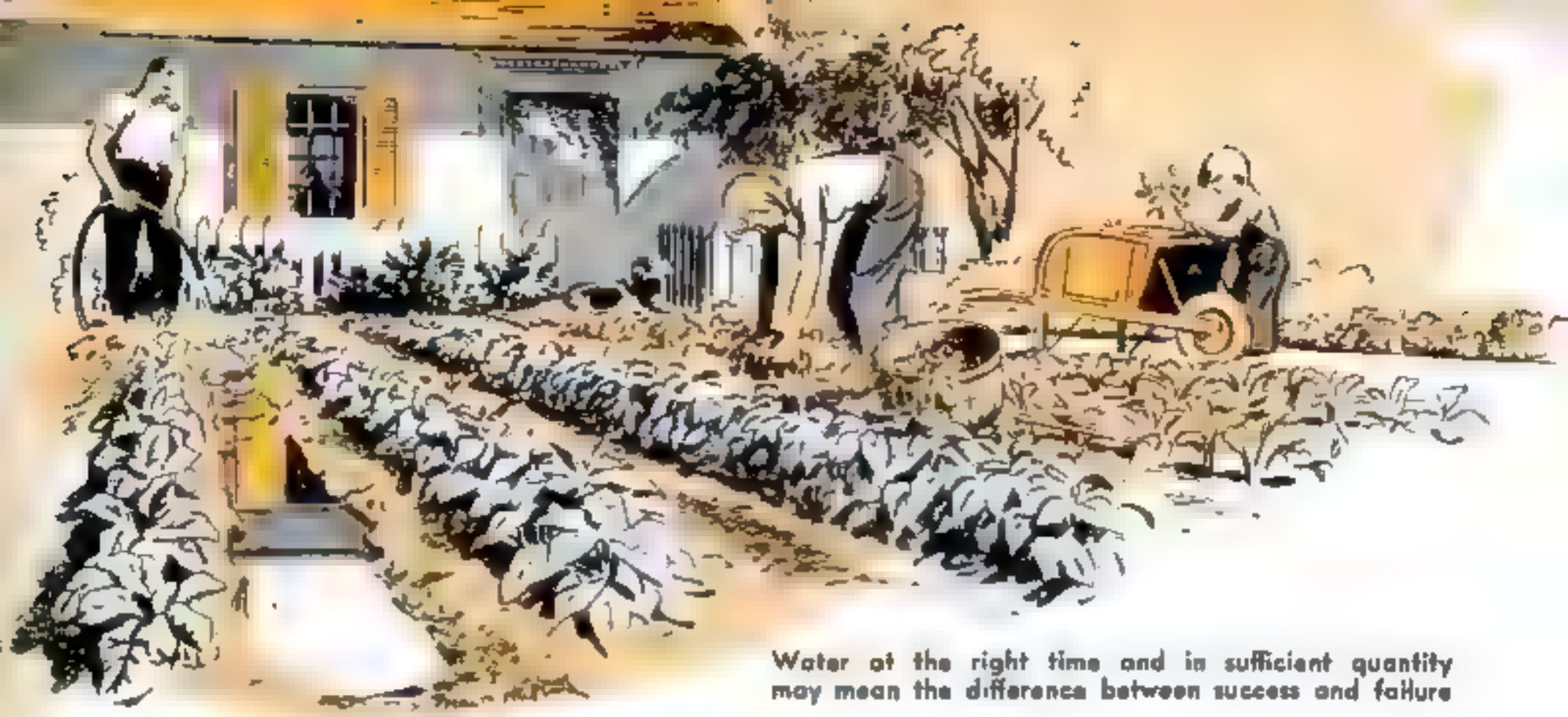
If an appliance is not equipped with a built-in control switch, a feed-through switch on the cord may be found convenient. Switches rated at 3 to 6 amps are suitable for use on lamps and light-duty appliances, but for heavier motors, large flood lamps, and the like the switch must be at least equal in rating to the current draw.

To install a switch of this type, first select a point in the cord at a convenient distance from the appliance. On heating pads, toasters, and similar appliances 18" to 24" from the unit will be most convenient, while on some other equipment greater distances may be preferred.

Carefully cut through the outer braid of the cord at the point selected, and push back or cut away this covering for a space a little less than the length of the switch. Cut apart one conductor only at the middle of this part, bare the two ends, twist the strands tightly together, and attach the ends under the switch terminal screws. Remember to wind the wires under the screws toward the right, or tightening direction, on the screw shank.

Bind the braid with narrow strips of adhesive tape at each end of the switch, lay the wires in the grooves in the switch housing, and fasten the other half of the housing in place with the screws provided.

POPULAR SCIENCE MONTHLY SHOP DATA



Water at the right time and in sufficient quantity may mean the difference between success and failure

How to Conquer Drought in Your Victory Garden

By E. W. LEHMANN

Head of Department of Agricultural Engineering, University of Illinois

THAT what you put into your garden bears a direct relation to what you get out of it in the way of good crops is never more true than in the matter of water. Upon *how much* water your garden gets and *when* may depend its complete success or its utter failure. Rainfall alone cannot be relied upon in most sections of the United States, especially during the hot, growing months of July and August. It is during these months that droughts are likely to occur, and it is then that supplemental water counts most.

Experiments conducted at the Illinois Agricultural Experiment Station to determine the value of irrigation resulted in increased yields ranging from 22 percent for tomatoes to 78 percent for onions. Celery and carrots showed increases of more than 50 percent when they got extra water at a time it was needed.

Simple hosing is often effective enough on a small garden. But it is likely to prove tedious, for the soil must really be drenched if the most good is to be had from the watering. Sometimes a light surface watering can even do harm by helping the soil to bake hard under the hot sun. To be effective, the water must soak down to below the roots of the growing plants.

Generally speaking, 1" of water a week will soak down far enough for most plants and keep them well supplied. If this is not provided by rain, then it is up to you. For leafy plants, more water is required. They are fast-growing and, in hot spells, may need as much as 2" a week.

Probably the easiest method of supplying this additional water is with a sprinkler. There are many types on the market, and any that will throw a heavy spray uniformly over the garden area will be satisfactory. Let the sprinkler run for an hour or so in one part of the garden; then when that is thoroughly wet, move it to another part. If your garden is too large for this to be accomplished in one afternoon, don't try to hurry the process; water as much as you can in one day, doing it thoroughly, and save other areas for succeeding days.

Many large growers have permanent

Where the plot is on a slope, ditches between the rows will carry water to all parts of the garden

sprinkling systems installed, either overhead or along the ground. Where uniform pressure is available and the investment warrants it, a system of this kind provides the quickest means of supplying supplemental water to all parts of the garden.

A homemade adaptation of the permanent sprinkler system is shown in one of the drawings. As recommended by the Rural Electrification Administration of the U.S. Department of Agriculture, it consists simply of a series of wooden troughs made from narrow boards nailed in the shape of a *V* and bored at intervals so water can drain out on the furrows. The ends of the troughs where the water is to be admitted should be higher than the others so that

Overhead troughs in a series to cover all garden areas provide a good homemade sprinkling system

the flow will be sure to reach the far ends.

Where the garden is on a uniform slope and the soil is clay or is sufficiently heavy, shallow ditches may be provided between rows and filled with water from the upper end. This can, of course, be done with the hose if there is running water close enough, but water can also be wheeled to the heads of the furrows in a barrel set in a cart or on a sled. When the barrel is in place, the bung is pulled out, releasing the water.

On level and uneven ground, a porous hose made of duck, canvas, or denim will be found convenient. A pipe line may be installed as a feeder along one edge of the garden at right angles to the rows and provided with tees, or the porous hose can be connected to the end of ordinary hose.

Such a hose suitable for the average Victory garden may be purchased, or it may be made of 10 or 12-oz. duck. It may be 3" or 4" wide and 10' or 12' in length, or as long as the rows. Sew up one end, as shown in a drawing, and attach a hose coupling to the other. Hose that is much longer than 12' should be made in several weights of material, with the lighter material at the far end. Any porous hose can be

Porous hose laid between rows will conduct water effectively and let it drain slowly into the earth

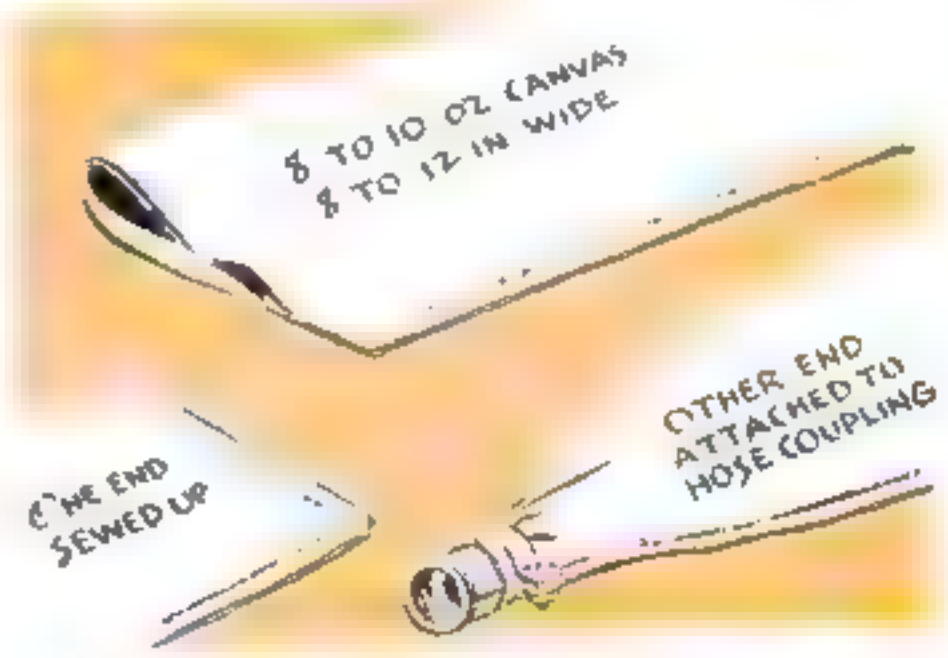
given extra life if it is treated with a preservative made of 1 part gasoline, 1 part kerosene, and 16 parts asphalt paint.

Attach the coupling to the garden hose or to one of the tee connections of a pipe line, plugging the tees not in use. Let the water flow until the ground adjacent to the porous hose has soaked up all it can; then cut off the supply, move the hose to another row, and wet that ground thoroughly.

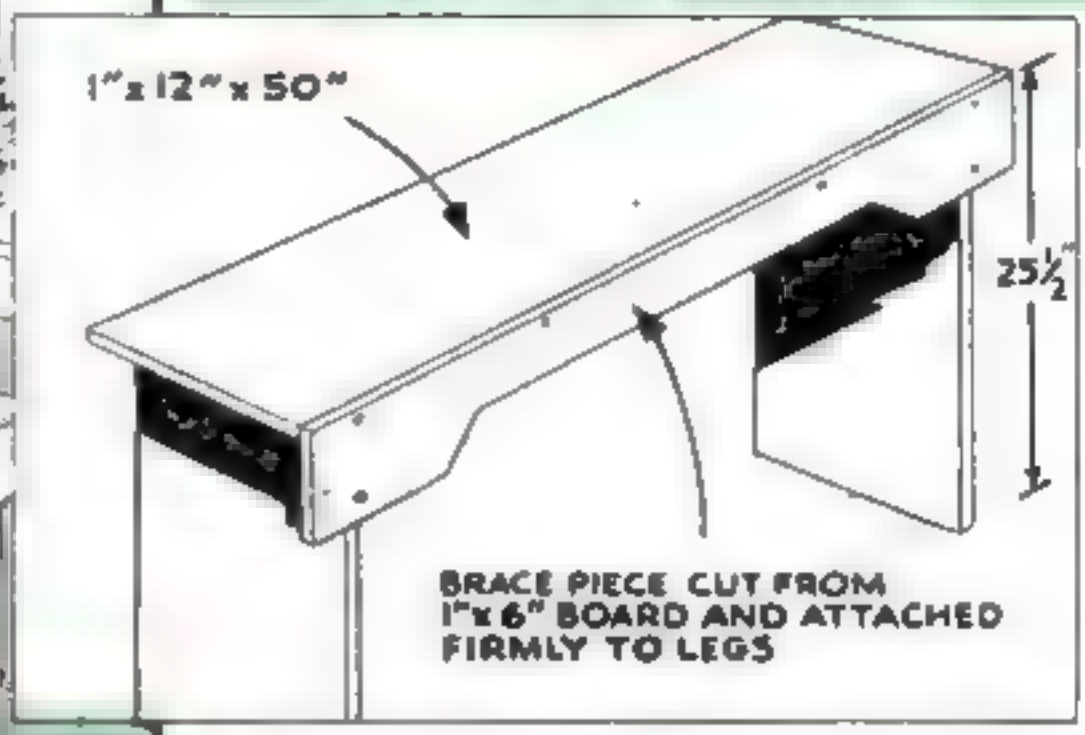
After any type of wetting, including rain, the surface of the soil should be cultivated into a fine mulch as soon as it is possible to work it without stirring up mud. A fine "dust mulch" helps to prevent excessive evaporation and conserves the moisture.

While uniform water pressure, such as is available from city water mains, is desirable, electric pumping units give good results with most sprinklers. Nozzles for both portable and permanent types should be selected to operate at a pressure in keeping with the pump, and their discharge capacity should be slightly less than that of the pump. Where the pumping unit has to supply water for the household and other purposes and has a limited capacity, the water may be put on the garden in the evening after the pump has taken care of the other needs.

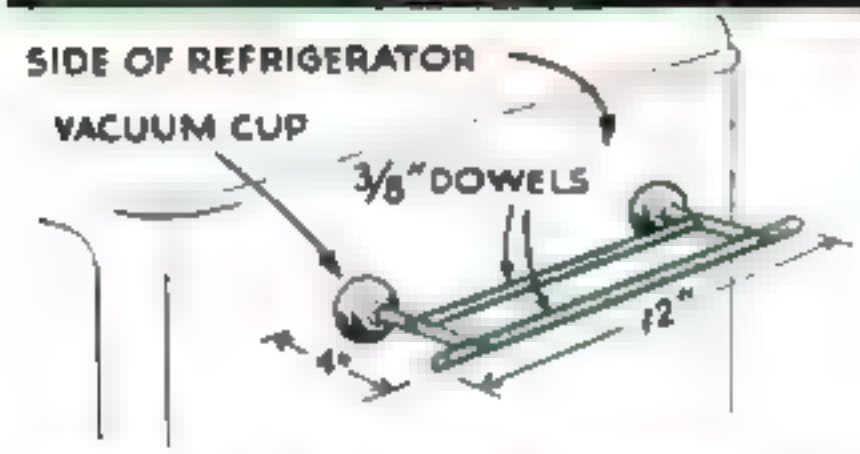
Here is how a porous hose is made. The coupling end is attached to a pipe tee or to a garden hose



GEEMING

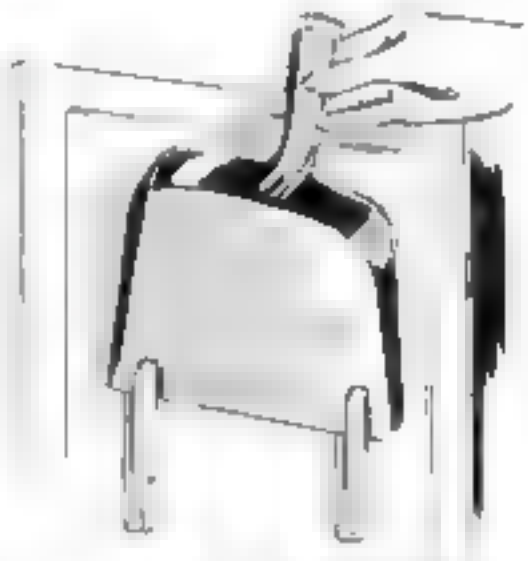


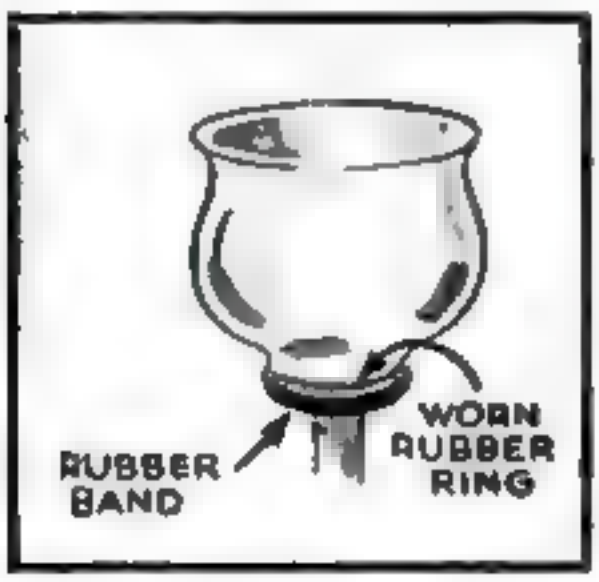
For the small room, in which a desk of regular size is too big, this writing table is ideal. It may also be used as an end or serving table. Use 1" stock for the legs, top, and brace piece. A colored-lacquer finish or a stain and varnish to blend with other furniture will be suitable



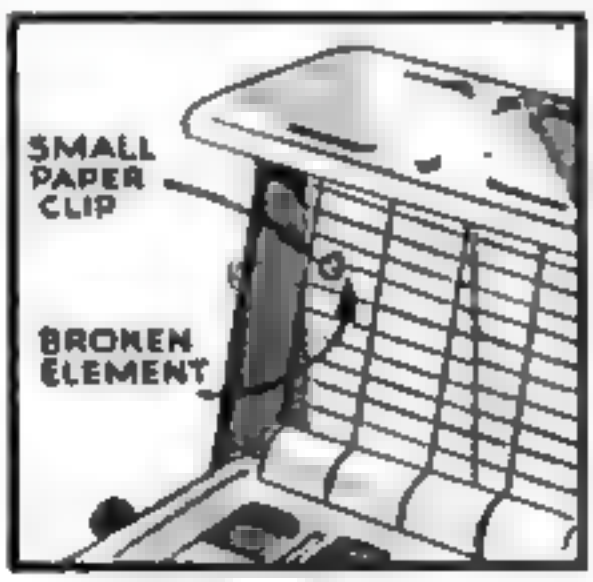
Four pieces of ⅜" doweling, six screws, and two vacuum cups make this handy rack. A few drops of glycerin under each cup will prevent its loosening

Two flat clothespins provide a neat holder for the dustpan and dust brush. Screw the clothespins to a door or wall. The dustpan slides into place, as shown at right, while the dust brush rests atop the pan, held in place by the handle and the door or wall

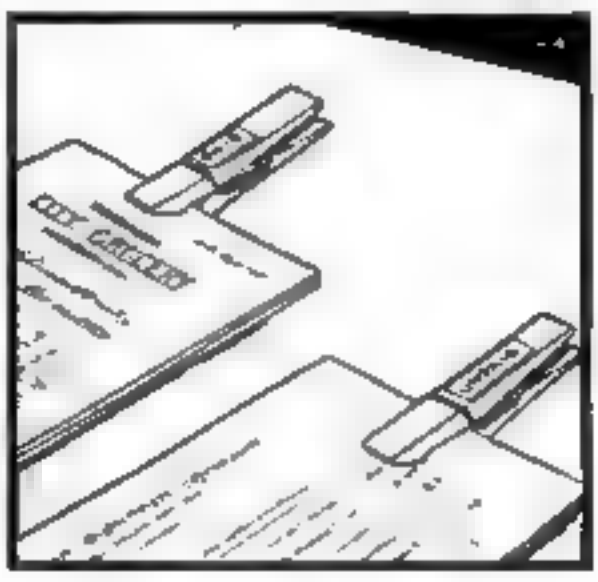




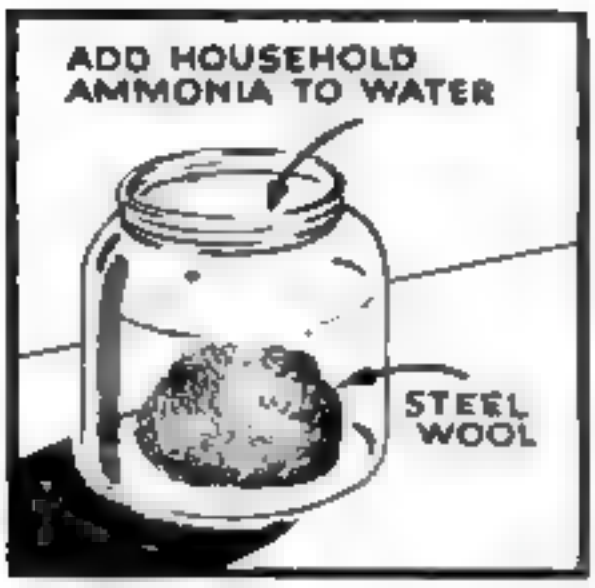
If the rubber ring on the upper section of your coffee maker is worn, cement a heavy rubber band over it. To insure a good seal between the bowls, moisten the band before assembling them



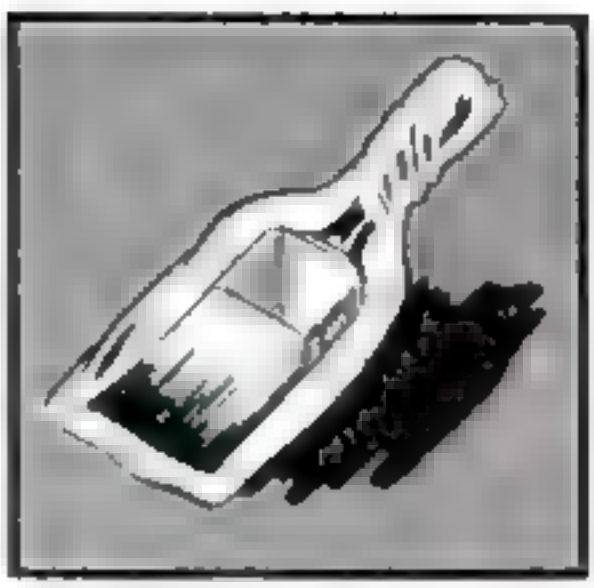
When the element in your toaster burns out or breaks, a temporary repair may be effected by using a paper clip to bring the broken ends together. Be sure the clip doesn't touch the adjacent wires



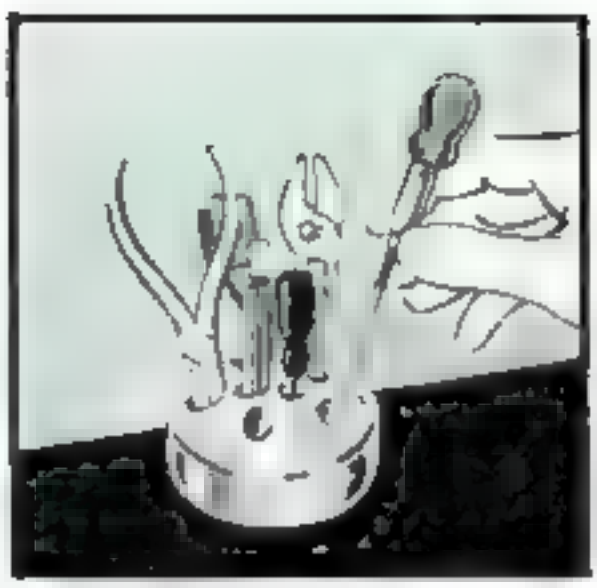
Snap clothespins make good clips for holding bills or papers. A pin can be finished in one color and its spring in another. The labels are made of paper, glued on and varnished for protection



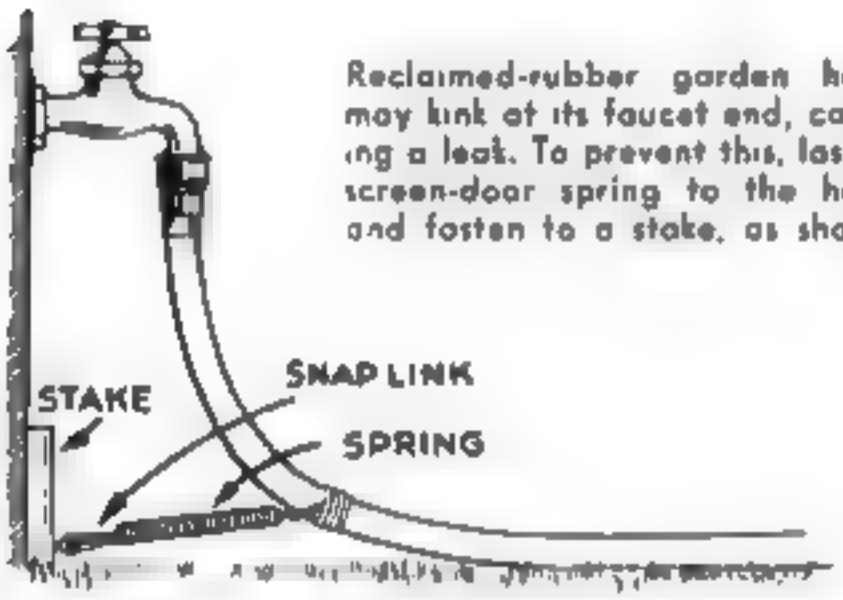
Steel wool may be protected from rust in a jar where it can be kept under water to which has been added a teaspoonful or so of ordinary household ammonia



To keep an uncleaned paintbrush soft overnight, slip it into a cellulose-film food bag and seal by twisting the neck of the bag tightly about the brush handle

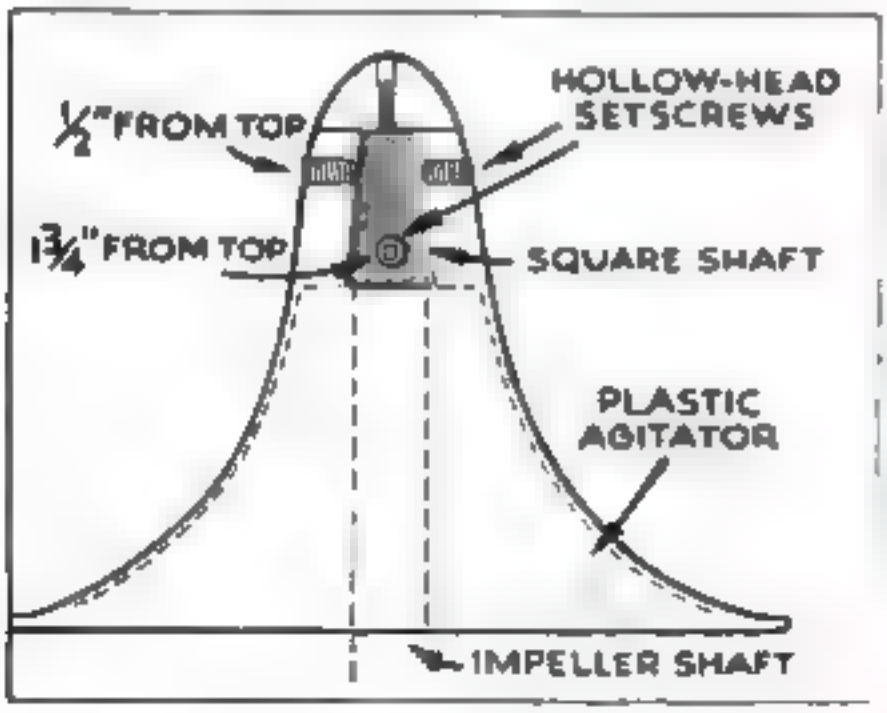


Small tools such as pliers and screwdrivers may be conveniently kept at hand on the shop bench by racking them in an ordinary round glass-block flower holder



Reclaimed-rubber garden hose may kink at its faucet end, causing a leak. To prevent this, lash a screen-door spring to the hose and fasten to a stake, as shown

When painting the edges and ends of a wood picket fence, try using a shoe-polish dauber. Not only is it easy to use, but it does a better job than a regular paintbrush, which may thus be conserved and used only on the wide front and back surfaces



If the tapered square shaft socket in the plastic agitator of your washing machine has worn so that the agitator slips, drill and tap four holes, two ½" down from the top of the head and two at right angles to the first two, 1¾" down from the top. Then secure the agitator with hollow-head screws

Chemistry... Weapon

EXPERIMENTS YOU CAN MAKE AT HOME SHOW HOW METHODS

In testing for arsenic, heat a sample as shown. If arsenic is present, gas will color the filter-paper cone at the top

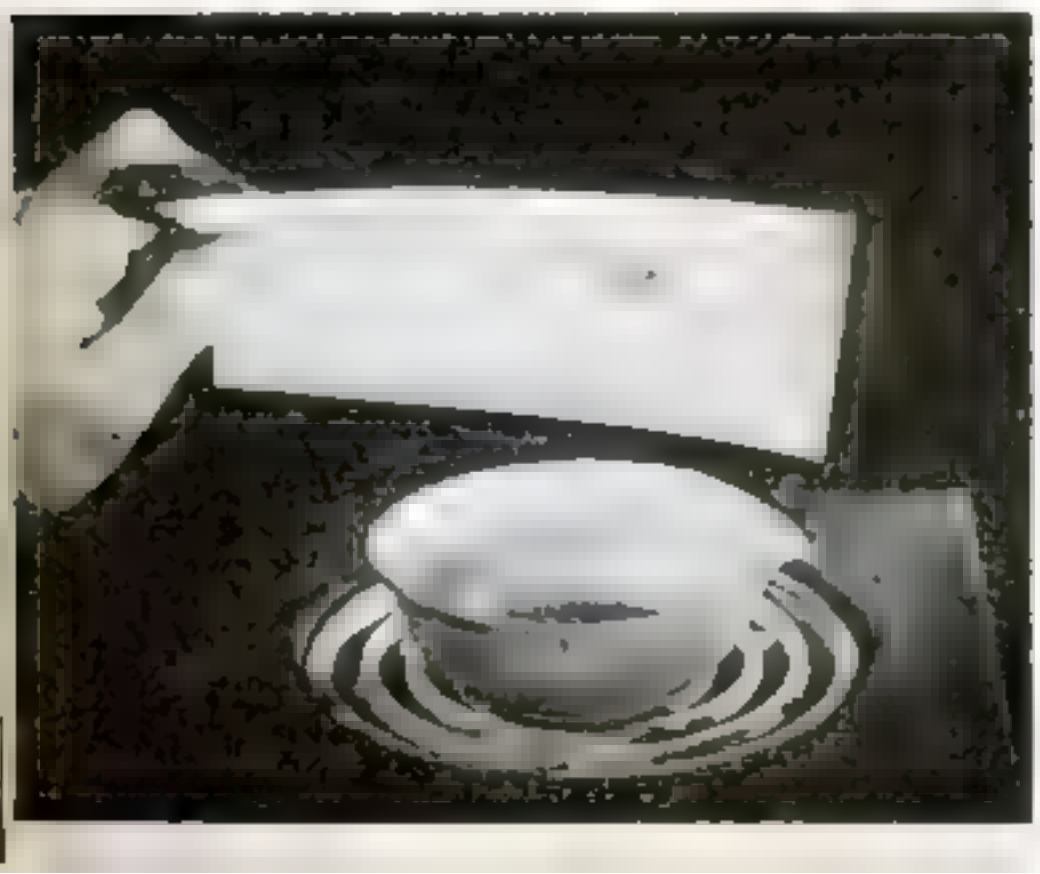
BY KENNETH SWEZEY

ALTHOUGH lone masterminds of crime detection still flourish in mystery magazines and novels, most crimes of today are solved by anonymous experts in up-to-the-minute laboratories. Armed with microscopes, spectroscopes, chemical reagents, and invisible light, these scientific sleuths, working with the FBI, Army and Navy Intelligence, and state and municipal police departments, are continually outwitting even the smartest of criminals.

Some tricks used by the chemical detectives are so delicate that they require a microscope and an analytical balance, but there are many interesting tests which may be performed with simple chemicals and equipment in the home laboratory.

Arsenic is a favorite poison with many storybook murderers. One of the simpler tests for it is the Gutzeit method. Set a glass tube, stoppered at its lower end, on top of a stoppered flask. To tie the assembly together, run a smaller glass tube through the two stoppers. Into the larger tube put, first, a small, loose wad of cotton wool; then add several crumpled sheets of filter paper, loosely packed. To absorb any hydrogen sulphide gas

Hidden fingerprints turn dark brown in color when inverted over the vapors from a strong, boiling solution of iodine in potassium iodide and water



Test a spot suspected of being blood by putting on it hydrogen peroxide and then benzidine in glacial acetic acid. Blood will turn bluish green

in the War on Crime

OF MODERN SCIENCE ENABLE POLICE TO TRAP THE CRIMINAL

that may form as a by-product, moisten the filter paper with a saturated solution of lead acetate. Place a cone of filter paper, which has been soaked in a solution of mercuric chloride and then dried, in the top of the larger tube.

To carry out the test, put a piece of pure zinc in the flask and add about 30 ml. of arsenic-free hydrochloric acid, to which several drops of 15 percent cuprous chloride solution have been added. Heat the flask gently until a reaction starts; then remove the flame, as the reaction will continue without further heat. If the filter-paper cone is not discolored after several minutes of operation, none of the reagents contains arsenic. Once sure of this, add a speck of some arsenic chemical to the solution in the flask and continue the reaction. The cone will soon show color, ranging from light yellow to orange brown, depending upon the amount of arsenic present. This color is made by the gas arsine, which is created by the generation of hydrogen in the presence of arsenic. (CAUTION: Use a tiny amount of arsenic in the second part of the test, and do not breathe the gas.)

Fingerprints, the most popular means of identifying a person, are transferred to objects by the fats, fatty acids, sodium chloride, and other chemicals exuded through the pores of the fingers. Perhaps iodine vapor is the simplest method of making such prints visible, especially if they are on paper. Prepare a strong solution of potassium iodide in water and dissolve as

SYMPATHETIC (INVISIBLE) INKS		
Ink	Developer	Color
Sulphuric acid	Heat	Black
Nitric acid	Heat	Black
Cobalt chloride	Gentle heat	Blue
Copper nitrate	Potassium ferrocyanide	Brown
Oxalic acid	Cobalt nitrate	Blue
Potassium thiocyanate	Ferric chloride	Red

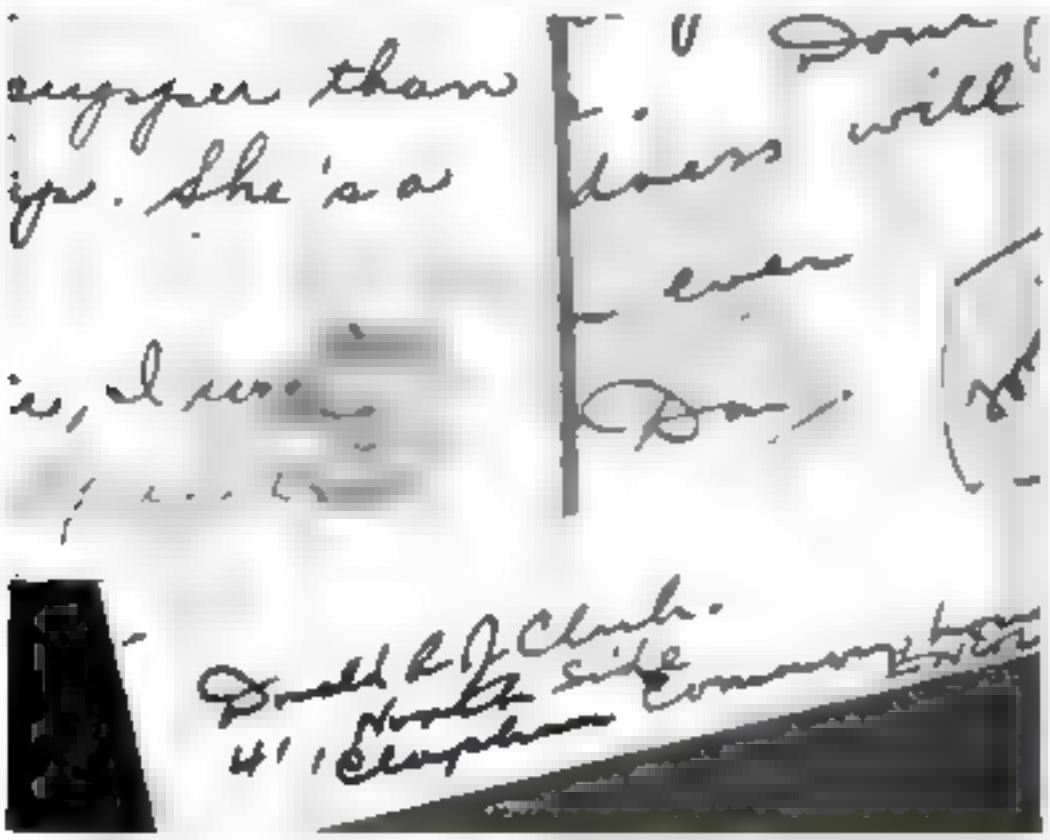
many iodine crystals in it as you can. Make several fingerprints on paper and hold the paper, print side down, over an evaporating dish in which a little of the iodine solution is boiling. The prints turn dark brown.

A brown spot, which you think may be blood, can be chemically tested to make sure. Prepare a saturated solution of benzidine in a small amount of glacial acetic acid. Moisten the stain with a drop of water and transfer a bit of it to a clean piece of blotting or filter paper. Add several drops of household hydrogen peroxide to the spot on the paper and then several drops of the benzidine solution. A bluish-green color will develop if the substance is blood.

Illegally altered documents are often a problem, with chemistry providing a means of detection. One method involves this simple test. Most inks contain a tannate of iron, with a dye that gives added color. After a document has been written with such an ink, slow oxidation of the tannate takes

For establishing the approximate age of ink, put a drop of watered oxalic acid on a portion of the writing. Fresh ink will spread more than old ink

Potassium iodide, iodine, and sodium and aluminum chloride make a universal developer for invisible ink. Other developers are listed in a table above



When writing done in ordinary ink (Fig. 1) is bleached out with common ink remover (Fig. 2), only the color disappears. The iron salt left becomes visible after being pressed by a piece of blotter treated with potassium ferrocyanide

Common metal salts can quickly be identified with the help of the three chemicals shown above. An aqueous solution of metallic salt is divided among three test tubes; then a few drops of one of the identifying chemicals are added to the first test tube, a few drops of another to the second, and a few drops of the other to the third. The color reactions are then compared with those listed in the table below to identify the unknown metallic salt used in this experiment

CHART OF COLOR TESTS FOR COMMON METALS

Metallic Salts	Ammonium Carbonate	Ammonium Sulphide	Potassium Iodide
Silver	White	Black	White
Lead	White	Black	Yellow
Copper	Blue	Brown	Light brown
Mercurous	Black	White	Olive
Mercuric	White	Black	Red
Ferrous	Dirty white	Black	
Ferric	Brown	Black	
Aluminum	White	White	
Chromium	Green	Green	
Nickel	Green	Black	

place. Finally another tannate is formed which contains more iron. This new compound strongly resists solution in water or weak acids. By virtue of this chemical change, it is easy to tell whether such an ink is new or relatively old. Apply a drop of a 5-percent solution of oxalic acid to the ink to be tested. If the ink is fresh, the color will quickly run. As its age increases, the tendency to run will diminish. The color in iron tannate ink more than six years old should not run at all.

Invisible or "sympathetic" inks are still important weapons of the spy. All consist of chemical solutions that are made visible by applying heat or, if heat produces nothing, by treating with other chemicals. A few common invisible inks, each with its method of development and final color, are listed separately in a table

A universal developer that will make almost any secret writing visible can be made by dissolving 4 grams potassium iodide, 1/10 gram iodine, 5 grams sodium chloride, 4 grams aluminum chloride crystals (do not use the anhydrous form), and 3 ml. glycerine in 50 ml. water. Apply this sparingly to the paper with cotton wool.

Although bleaching solutions, or ink eradicators, may make ink writing completely invisible to the unassisted eye, they do not fool the chemist. All they remove is the pigment; the iron base of the ink remains in the paper. It can be made visible again by chemical means.

Bleach out some ink writing and prove it to yourself. If you have no ink eradicator, a little household bleaching solution having a chlorine base will do. After the paper has dried, press a strip of blotting paper, moistened with a solution of potassium ferrocyanide, tightly against the eradicated

writing. The ferrocyanide will react with the iron salt still in the paper, making the ink again clearly visible.

Often the dust on a suspect's or a victim's clothing will identify his habits or occupation. Because the available dust is generally so minute, its analysis is really a job for the microchemist. He first carefully examines the dust with a microscope, heats it next in a crucible to burn away any organic material, and then tests the residue for inorganic chemicals.

Some useful tests for salts of metals made in this connection involve interesting color changes. These can readily be done at home. You need solutions of ammonium carbonate, ammonium sulphide, and potassium iodide.

To make a test, dissolve a speck of some metallic salt in water. Put a little of this sample into each of three test tubes. Add several drops of the ammonium carbonate solution to the first tube, ammonium sulphide to the second, and potassium iodide to the third. A different colored precipitate will form in each tube. The combinations of color vary, depending on what metallic salt has been used, as indicated in the table on the facing page.

America's Favorite Gun

(Continued from page 87)

more than five shots for use as a hunting gun.

The Army asked for a five-pound gun with an effective range up to 300 yards. After tests of seven that were offered, the Winchester model was adopted. By effective range, the Army means that you can hit a man at that distance.

The accuracy of the .30 carbine can be judged by the following table showing its extreme spread in a test at Aberdeen Proving Grounds:

Range	Spread
100 yards	2.2 inches
200 "	4.7 "
300 "	7.6 "
400 "	11.2 "
500 "	16.3 "

Since the carbine was developed as a substitute for a pistol, it is hardly logical to compare its accuracy and penetration with that of high-powered rifles. The gun itself weighs a little over five pounds, which is not much over half the weight of the Garand. The cartridge is a peewee as compared with the Garand and Springfield ammunition, even though all are of .30 caliber. It was designed that way for very good reasons. The troops who use the carbine are generally loaded down with a lot of things besides their guns. They need a light gun and light ammunition. The carbine cartridge itself weighs just half as much as the Garand ammunition, which means that the men who use it can carry a good many rounds.

One of the features that endear the carbine to service men—its automatic firing—makes hardheaded sporting-gun experts skeptical about it as a game piece, for it is a fact that hunters have not taken kindly to automatic rifles in the past. There have been good automatics on the market for many years, but they have never become as popular as the old reliable lever and bolt-action rifles of song and story. There is wide difference of opinion as to why this is so. Some say it is because the automatics are not as accurate, some that they are not as well-balanced and smooth-handling. Some hunters heartily dislike the slam-back action of the autoloading mechanism.

This last-named objection, at least, has been nullified in the .30 carbine, and the secret of its soft-feeling recoil doubtless is in the gas-and-spring operation of the reloading mechanism. Like the Garand, it utilizes gas pressure from within the barrel, which is admitted to a cylinder through a small opening. But it departs radically from the Garand's design, too. The gas port on the Garand is an inch and a half from the muzzle; on the carbine it is five inches in front of the breech.

The designers of the carbine placed the port far back for the reason that they had a relatively light charge of fast-burning powder with which to work, and gas pressure is greatest near the breech, diminishing rapidly toward the muzzle. The result of this experiment was highly successful, suggesting that the Garand might be improved by moving the gas port farther back.

Without its specially designed cartridge, the carbine could not have achieved its great success as a fighting weapon. The 110-grain bullet leaves the muzzle at 2,000 feet per second, a velocity that compares quite favorably with that of higher-powered loads (in the .30 '06, it is 2,700). This speed is obtained with a special powder in the form of extremely small balls. (P.S.M., Dec. '43, p. 92.) A high velocity is obtained for a relatively short range, and that is what the carbine is designed for—quick and deadly action at close quarters. This is not a characteristic especially to be desired in a big-game gun. Hitting power and accuracy at long range are the qualities the big-game hunter wants above everything.

Alcohol Handles 1,000 Jobs

(Continued from page 144)

and replaced by an atomic combination, or radical, of oxygen and hydrogen. Theoretically, this is simple. But it is not so easy in practice. To produce an alcohol, chemists are often forced to use roundabout methods.

Synthetic alcohol can be made from by-product hydrocarbons of coal or petroleum gas. Between 60 and 75 million gallons a year are now produced this way. There is enough ethylene gas available to synthesize all the alcohol that America needs, but the construction of new synthetic plants would require metals and machinery that cannot be spared immediately. Most of our war alcohol, consequently, has been produced by the ancient process of fermentation.

Any vegetable material that can be changed into a simple sugar can be fermented by yeast into alcohol. But different raw materials must be handled differently, and this was one of the problems that confronted American scientists when substitutes were sought for blackstrap molasses. Even wood, straw, or other cellulosic material can be partly changed into fermentable sugars now.

When the yeast, which is grown under carefully controlled conditions, is added to the sugar, fermentation proceeds for two or three days, during which the sugar is broken down into alcohol and carbon dioxide. Fermentation stops when the concentration of alcohol in the mash, known as "distillers' beer," reaches seven to nine percent. Additional concentration is achieved by distillation.

If the antifreeze alcohol ever boiled out of your car radiator, leaving the water behind, you have had a lesson in fractional distillation. Alcohol boils at 78 degrees centigrade; water boils at 100 degrees C. When they are mixed, the boiling point may be between 85 and 90 degrees. Although the vapor contains both alcohol and water, it is richer in alcohol than the parent mixture Passing this vapor over surfaces cool enough to condense the water but not the alcohol turns back much of the water, leaving a vapor of nearly pure alcohol.

New and vastly more efficient methods of producing alcohol have been developed recently. By a flash-conversion process, for instance, grain mash now can be cooked in four or five minutes in relatively compact vessels. Formerly, it had to simmer for many hours in enormous kettles. Both time and strategic materials have thus been saved.

The next step, the changing of starch into fermentable sugar, has been shortened to a mere 40 seconds by raising temperatures and pressures. This new process is also reported to obtain an additional tenth of a gallon of alcohol from each bushel of grain.

The big, continuous stills of a modern alcohol plant are much more complex than the retorts of alchemists. "Distillers' beer" is admitted at the top of the first of two tall towers. Steam rushes up from the bottom and vaporizes part of this beer. The vapor is then condensed into "high wine."

This, in turn, is vaporized and passed upward through perforated metal plates, or piles of hollow brick tiles, in the second, or rectifying, tower. Most of the water in the mixed vapor condenses on these plates or tiles. The almost pure alcohol vapor then is finally condensed and allowed to flow out through a glass-enclosed "tail box," where its proof can be constantly checked with hydrometers.

Under Department of Agriculture supervision, pilot plants to provide the basic knowledge needed for the construction of full-scale wood-waste distilleries are operating now in Michigan and Tennessee. Until recently, the chief obstacle to the use of wood was the immense amount required to keep a fair-sized alcohol plant going. The best American process yielded only about 20 gallons of alcohol from a ton of wood. But that ratio has been more than doubled by a German process that is now available for use in this country.

At one time there were only nine U. S mills big enough to support a 1,000,000-gallon-per-year alcohol-hydrolysis plant operating on the old basis. Now, because the new process requires less than half as much wood, there are 73 mills that can support such plants, and it is estimated that such plants could produce 500,000,000 gallons a year.

The waste liquors of sulphite paper-pulp production already are being used commercially. Sugars are produced from the cellulose of the wood as a by-product of the pulping operation. About three fourths of these sugars are fermentable by ordinary yeasts, and about 18 gallons of alcohol can be obtained as a by-product of each ton of pulp.

At the Thorold plant of the Ontario Paper Company in Canada, more than a million gallons of alcohol for butadiene will pour through the condensers this year—alcohol to help fight a mighty war, and conjured up by chemical magic from waste.—KENNETH M. SWEZEY

How Planes Smash Bottlenecks (Continued from page 103)

had still been in the last phases of organization for this particular job when our air force began its first missions designed to whittle down the enemy's air defenses and gain air mastery. Now it is moving in, being assigned sectors, getting set for its turn in the big show. And now our airborne troops are at work; paratroopers are getting in behind the enemy's lines, completing the job of disrupting communications and support, rounding out the task of isolating the area.

Things are getting hot. Bombardment tempo increases. The enemy must be knocked off balance, and kept off balance if possible. He must have no rest, no chance to bring up support. Yet he must be kept in doubt about where the major blow will fall; so diversionary attacks are made, not only in this area but in other areas perhaps far away.

We reach the hour of attack. Artillery has been supplementing air action. Now both armored forces and infantry begin to move. They are soon in the zone of contact. The battle is joined.

Ideally, our air force will have softened up all enemy strong points. Actually, some of those points will have escaped or will have been reconstituted before our land forces strike them. That means trouble. It means that new support must be given, quickly and in overwhelming strength.

This time we have three hot spots where the land advance is seriously endangered. A tank concentration at Point M is holding up the attack; at Hill K there is an installation that is knocking our attacking tanks galley-west; at Point X we have run into a knot of brand-new machine-gun nests of concentrated strength. Hill K seems to be the most critical of all, for unless our tanks get through there, we shall be held up all along that sector. The enemy tanks at Point M are next on the list; if they should break through instead of merely holding, they could raise the very devil behind our lines. Point X is only potentially critical, for it can be enveloped from the flanks.

Word flashes to a skip-bomber unit to go after Hill K. They can go in with bombs that will smoke up the place long enough for our tanks to get past, and they can follow with "frag" bombs, which will soften up the place for infantry attack. And word goes to another field for both skip bombers and strafers to go after those enemy tanks at Point M, and to come back over Point X.

We wait, and watch the reports from other sectors. No unusual trouble. Point X reports in, more insistent, and is told to hold on, help is coming. Point M reports a break-through threatened by those enemy tanks. But Hill K soon reports our own tanks moving on up the valley, enemy guns blanketed by WP smoke and firing wild. We draw a deep breath of relief. But Point X reports that pressure is severe and it will be necessary to fall back. Tanks have come up and are attacking through machine-gun nests—enemy tanks.

We have no fighters available for reinforcement there. Word goes to medium bombers, one unit of which is just back from a forward mission: "Strafe, bomb, and halt enemy tank attack at Point X." A fighter unit detailed to strike at Point X as a secondary mission is ordered, instead, to proceed to Hill B, which has just reported trouble.

The attack moves on. . . .

That is the pattern, as it was worked out under fire, in Africa, in Sicily, in Italy, in the Pacific. Air support, as we once knew it, is but a part of the picture. Now all branches are co-ordinated in one over-all plan. It calls for the utmost in co-operation, and it provides the maximum of flexibility. It gets results.

The setup is the logical result of the new conception of air power. Many of its details were worked out at the Air Force Tactical Center in Florida, not by air men alone but by men from all branches, who sit down together there and learn how best to utilize everything in the arsenal—air, ground, artillery, sea, and all overlapping forces. Problems were set up and run through, with high officers from all branches working together and learning how best to co-ordinate the various forces.

The new system was tested under the most difficult field conditions that could be simulated here at home. At each stage of its development, reports were sent to field commanders in active theaters. Their reports came back, and often the officers themselves, to confer, consult, and advise.

Out of tactics came developments in basic strategy, and thus the whole program was integrated. So if you seem to see parallels between tactics and broad strategy, you are not seeing things in the dark. You are seeing the broad doctrine in action. Combined operations are no longer confined to a landing force. All our operations now are combined operations.

Fighting at 425 M.P.H.

(Continued from page 114)

cannon. Americans didn't go for it especially, although they did take it in a dive-bombing version known as the A-36 Invader, which did fine service in the African and Sicilian campaigns.

The British liked the Mustang tremendously, and it was their idea that it should be fitted with the Rolls-Royce engine, which the British (not without reason) consider the outstanding mechanical phenomenon of our time.

Thus it was that the new Mustang was fitted with the Packard version of the Merlin engine in the latest type—with a two-stage supercharger making it the equal of any aircraft in high-altitude performance. This engine has a confessed horsepower rating of 1,520, and gives the plane maximum effectiveness three miles higher than any earlier P-51. But it is still good close to the ground, as evidenced by the sudden emergence of Lt. (now Captain) Don S. Gentile as a leading ETO ace with 27 planes destroyed, a half dozen of them on the ground.

The P-51 is 32 feet three inches long, 12 feet eight inches high, and weighs 9,000 pounds. It has a wing span of 37 feet and a tail span of 11 feet 10 inches. Its wing area is 233 square feet. To handle its tremendous power it has a four-blade propeller, 11 feet two inches in diameter.

The new Mustang soon demonstrated its ability to outclimb, outrange, and outmaneuver any German aircraft. In three consecutive raids the Mustangs shot down 30 Germans without a loss. Jerry does not like to tangle with them.

IV

Recently North American was permitted to announce that the Mustang, with a published speed of 425 miles an hour, is the fastest aircraft on earth—capturing this rating from the twin-engined British Mosquito.

Various factors in the new version contribute to this speed. One of these is the exhaust ejectors at the side of the engine cowling, which are worth 200 or more horsepower in propulsive effect. Even more important is the redesigned cooling system, which gives the airplane its characteristically fat belly.

This radiator cowling is set far back, so that the entire front end of the airplane is very clean, striking undisturbed air. But especially important is the fact that this system is so designed that air passing over the radiator and expanded by heat is ejected through a much smaller flap opening at the rear. This use of the principle of jet propulsion recovers 80 percent of the power lost through drag of the cooling system.

As for the engine, which also has a lot to do with it, let me tell you the story of one of Howard's flyers:

Lt. Clayton K. Gross, of Spokane, Wash., has been shot at plenty, which is why his Mustang is called "Live Bait." But worst of all was the day coming back from Frankfurt, when suddenly his wing man was gone and there behind him were four Focke-Wulf 190's roaring in to complete the kill.

Gross went right through the gate into the kitchen. He did a split S to the deck and stayed there, with his throttle on the fire wall.

He soon lost his pursuers. But the next 40 minutes — tearing through telephone wires, clipping the tops of trees, skimming housetops, dodging windmills at more than 400 miles an hour—were the loneliest of his life.

The trip was eventful. At one point Gross was suddenly enveloped in a grinding, blinding flash and shower of sparks. His Mustang had ploughed through a set of high-tension wires. But it never faltered. Once he ran into six Focke-Wulfs and thanked fortune their wheels were down for landing

When he had gone into the kitchen—that is, into a turning dive with everything on—he had pushed the throttle as far as it would go, past the gate, the maximum military power. You are permitted to go to a "war emergency" manifold pressure for five minutes. But as Gross came in to circle his home airdrome, he realized he had been against the fire wall all the way. This Packard-built Rolls-Royce Merlin engine had been pulling "war emergency" for all of 40 minutes. And she was still doing it like a sweetheart.

This Mustang had come back with its air scoop, under the belly, half torn off, with a yard length of ⅜-inch high-tension cable embedded in the radiator. But what really made the ground crew bug-eyed was the engine and what it had stood.

Lt. John Konopka, who mothers the Mustangs with passionate zeal, drained the oil and strained it, hunting for metal chips. He had the crew tear the engine down and reassemble it, gave it an hour's slow flying, drained and strained the oil again. Not a chip or sign of wear. Everything perfect.

"Boy!" said Konopka. "That Merlin may be English, but it sure is some engine!"

Finish Fight

The Army Navy E flies above four Fisher Body plants for excellence in aircraft production and from two others for tank production. Once the Navy E with four stars, is flown by still another Fisher Body plant for its naval ordnance work.

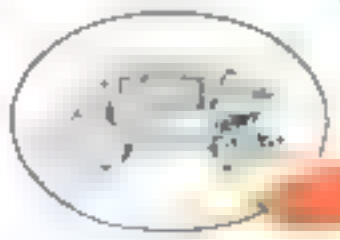
IT'S a hard-hitting brute—this dual-purpose 5-inch gun. It's the kind of fighting tool needed to smother enemy fire power, to give our men a life-saving advantage when the going gets tough.

We cannot take credit for *all* of it. This big 5-incher was designed by the U. S. Navy, and its production is a tribute to the cooperation of thousands of workers and several companies.

But as we see it come down the Fisher assembly lines, we get a thrill of pride out of the work we have done on it. It's proof that Fisher craftsmanship has once more been pointed right, has once more registered a hit on the production target.

Whether it's bombers, fighting planes, tanks, anti-aircraft guns, delicate flight instruments or other armament to be built—Fisher craftsmen are on the job till they get it ironed out. That goes for some very rugged problems put up to us by the men who do the shooting. And in this fight to the finish, we intend to stay right in the middle of such things until the final bell rings.

Every Sunday Afternoon
GENERAL MOTORS SYMPHONY OF THE AIR
NBC Network



armament BODY BY Fisher

DIVISION OF GENERAL MOTORS

When lint collects upon a suit,
Or threads on dresses stick,
Some Texcel Tape–rolled inside out–
Will pick it off–but quick!

And when this calendar was hung
No hole was left to gape,
For neither nail nor tack was used.
What was? Why, Texcel Tape!

So many things about a house
This Texcel Tape can do–
From wrapping up to fastening down
In place of strings or glue.

For Texcel is an improved tape
Whose "stick-um's" bonded on.
It won't come off, it won't dry out
Before the judgment dawn.

Since all the Texcel Tape that's made
Is being used for war,
Buy Bonds and Stamps 'til Victory
Returns it to your store.

Texcel Tape

CELLOPHANE TAPE — STICKS WITH A TOUCH

Made by
Industrial Tape Corporation
A Division of
Johnson & Johnson
New Brunswick, N.J.

Repair-Yard Miracles

(Continued from page 77)

Glittering in the Sun." She has survived attacks coming from both above and below the water.

A Nazi submarine commander thought he had her number when he espied her traveling in convoy in mid-Atlantic nearly four years ago. "Before we were even attacked," says the tanker's captain, "we heard the Germans report on the radio that they had sunk the whole convoy." The *Solfonn* and other merchant ships were saved that time by the *Jarvis Bay*, the armed raider that gained renown by tackling and routing a German pocket battleship. The next spring, off the coast of England, the *Solfonn* found herself under attack by the Luftwaffe. The Nazi planes just barely missed her with their bombs.

It was the rocks off southwest Africa that finally made her a challenging and memorable case for the ship surgeons. She was running with empty tanks from Cape Town to Durban to pick up a new cargo. She had orders to hug the coast because of submarines. The African shore was completely blacked out and the *Solfonn* lunged into "the graveyard of ships" near Bird Island. There her bottom was ripped to shreds.

"I was asleep when it happened," her captain recalls. "I heard a big crash and thought we were torpedoed. It knocked me out of bed, and it felt like the whole ship was falling apart.

"We sent to Port Elizabeth for assistance, but it took eight hours for help to arrive. Meanwhile we got help from a small freighter. She tried to keep the stern up, but couldn't keep position because of the current. We had the air pressure on and were using the engine to try to get off, bumping against hard rock all the time.

"It was the air pressure from the tanks that saved us. We were actually floating on air, and if we'd been a freighter we would never have come off."

Tugs came out from the mainland and tried in vain to free the *Solfonn*. All but 10 men were taken off her. The captain expected her to buckle and crumble away in another two hours. Then the *Solfonn* suddenly and surprisingly freed herself, "quite smoothly, just like the launching of a new ship."

They took her to the Cape of Good Hope, where she waited six weeks for a berth in Simonstown. It was impossible to rebuild her there, so they just gave her first aid. They put four longitudinal girders and some new plates and brackets into her, then flooded her leaking bottom with from three to four feet of cement and reinforced concrete. Thus mended, the *Solfonn* crept from the southern tip of Africa to Baltimore for a major operation.

Before she could be put into the 20,000-ton floating dry dock used as an operating table there, a diver had to go down and examine her underside. When all possible obstructions had been noted, she was eased in and raised out of the water.

Six hundred tons of concrete then had to be dynamited out of her. It was extremely delicate work, partly because of the intricate arrangement of heating coils and machinery in her, and also because of the necessity of keeping her securely and evenly at rest on keel blocks. She was so badly damaged that she might easily have toppled over and wrecked the dry dock. But transit readings were taken from time to time to note any shifting or settling of the hull, and she was repaired section by section.

It took 1,000,000 pounds of shell plating and 1,500,000 pounds of internal steel to make a new woman out of the *Solfonn*. The general superintendent of the yard, who had been rebuilding ships since 1906, called her the biggest repair job ever undertaken in any of the huge yards near Baltimore.

She's back in service now, apparently as unsinkable as the legendary Flying Dutchman, but always making port.

"This is a war of ships," Rear Admiral E. S. Land, chairman of the Maritime Commission, and the War Shipping Administrator, has emphasized. The ships that were kept plowing the seas despite the enemy's attacks helped make possible the American advances against the Japanese and the invasion of continental Europe.

Long before D-day, the command of an American naval hero—"Don't give up the ship!"—became the motto of the men in the repair yards as well as the men at sea. Three dozen skilled trades are involved in ship construction, and many more often have been necessary to salvage a ship and send it back to sea.

Postwar Television

(Continued from page 83)

hundreds of transmitters will have to be built, network facilities provided, program-production studios and organizations set up.

All this cannot be bitten off and swallowed in one gulp. It has to be done in stages. First we might install a relay system between Washington and Boston via New York; that will take a year or two. With the bugs ironed out, that pioneer network may be extended westward. At the same time a West Coast network may work its way from San Diego to Seattle in perhaps four years, with tentacles reaching eastward. Finally the east-west arms will join, like the railroads in the late 1860's. Transcontinental television is something on the order of a five or 10-year proposition.

One more word of caution. Television cannot stand much interference. The Federal Communications Commission will have to regulate industrial and medical radio devices such as diathermy equipment, which can raise hob with all the television receivers in their neighborhood. Electronic services must not be allowed to get into each other's hair. Secondly, the manufacturers of television receivers must do better than they have done with broadcast receivers, as far as reliability is concerned. If the telephone system used electronic equipment as undependable as many radio receivers of reputable makes, getting through a long-distance call would be a gamble. A 20 to 40-dollar radio will frequently incur from 50 to 100 percent of its initial cost in service charges during its normal amortization period. A television receiver is a far more complex instrument. Television receiving equipment will have to be much better than broadcast equipment, and television service men will have to be better trained, or progress of the industry will be retarded.

If television is not going to be borne in on the wings of the angel of peace, frequency modulation may well be. It has no missing links; its economic problems are on a much smaller scale than those of television; and the greater part of its pioneering has been done. Its full development is overdue and only wartime restrictions stand in the way

Actually, one of the principal functions of medium-wave amplitude-modulated transmission was lost as long ago as the advent of network broadcasting. Once the novelty of distance reception had worn off, it became only a matter of time before a short-wave, short-range, interference-free link between the town radio audience and the local network outlets would supplant the

(Continued on page 232)

He Grew Up with Radio

The Story of William C. White

RADIO and William C. White, now engineer in charge of G.E.'s Electronics Laboratory, were both only youngsters when he became fascinated by wireless and electrical gadgets.

His interest in radio began when he had the measles. His father bought him a book on the subject, one of the first ever written. Young Bill read through it eagerly, especially a chapter on how to build a radio set. As soon as he was out of bed, he started to make one—from curtain rods, brass bed knobs, and odds and ends of wire.

When he finished high school, he went to Columbia University to study electrical engineering, and the summer before graduation he worked in the General Electric Research Laboratory. By this time he had been thrown out of most of the wireless stations in New York—which he was haunting in order to learn more about technique and equipment. The first vacuum tube he ever saw was in one of these stations.

After graduation from Columbia he returned to the Research Laboratory as an engineer assigned to vacuum-tube research, to try to find new ways of using the tubes.

So great was the growth of radio—and television, too—that within a few years the work required an engineering division of its own; and Bill White took charge. Then in 1941, with the formation of General Electric's Electronics Department, he was placed in charge of the Electronics Laboratory.

Because William C. White believed in creating his own new job in a new industry and making it a job he could grow with, his knowledge is today playing an important part in developing communications for war. After the war, he will have new ideas that will improve radio and television for all of us. *General Electric Company, Schenectady, N. Y.*

Hear the General Electric programs: "The G-E All-girl Orchestra" Sunday 10 p. m. EWT NBC "The World Today" news every weekday 6:45 p. m. EWT, CBS

BUY WAR BONDS AND STAMPS

GENERAL ELECTRIC

SCREWBALL IDEAS ON BATTERY CARE #5

Marmaduke Daffy thinks he's charging his battery by driving down to the corner store each evening. Fact is, his starter and lights use up more "juice" on these short trips than his generator can replace. Better walk, Marmaduke. You're wasting gas and tires.

1 Don't buy *anything* you can do without.

2 If you MUST buy, insist on dependable, long-lasting merchandise.

3 Take care of the things you have. Make them *last!*

These conservation rules save materials for war production, help curb inflation, give you more money to invest in War Bonds.

...THE WISE WAY IS PERIODIC RECHARGES!

RESTRICTED driving is bad news for batteries. Many cars aren't being driven enough to keep the battery properly charged. But you needn't let your battery weaken and "die".

Take it to your Exide Dealer for periodic recharges. That way, you can avoid starting trouble and postpone the day when you'll need a new battery. When you *must* buy, get a dependable, long-lasting Exide. Buy to Last—Save to Win.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 32

Exide Batteries of Canada, Limited, Toronto

EXIDES ARE USED IN MORE THAN 100 APPLICATIONS BY OUR ARMED FORCES

Need a Motor that can lift 500 times its own weight?

THIS electric motor weighs only a pound. But more power is packed in that one pound of motor than has ever been before.

With Lear gearing it can handle a quarter-ton load.

And it has to be ready to do that in an in-tant Because this motor moves control flaps, and heater shutters on warplanes. And air pres-sures mount high at the speed these ships fly

On aircraft, even the weight of a coat of paint has to be considered So this motor had to be light.

There's little room in an airplane So it had to be small.

Designing it meant starting from scratch There was no precedent for this kind of en-gineering

You may never need a motor like this. It may cost more than you might want to pay.

But if you are looking ahead toward manu-facturing some peacetime product, we want you to know that such a motor has been de-veloped along with 250 other Lear products

And equally important, we want you to know that there is available the kind of engineering thinking that could conceive and produce it.

LEAR AVIA INC. PIQUA OHIO

Postwar Television

(Continued from page 228)

longer-wave amplitude-modulated service.

Frequency modulation is *not* inherently high in tone fidelity. It *is* inherently high in freedom from interference, especially from natural static. In a sense, that is why it was invented. Around 1920, every radio engineer with any inventive pretensions was trying to eliminate static—the bugaboo of long-wave reception. Except for the amelioration afforded by sharply directional reception, which was not applicable to broadcast reception, all of their countermeasures failed. The proposed solution of E. H. Armstrong was one of the least successful; it was demolished in the discussion which followed the presentation of his paper on the subject, and nothing more was heard of it.

But that failure set one of the most powerful and lucid technological minds of the 20th century off on one of its exploring expeditions. The reason static could not be eliminated was that, once the impulses had got into a conventional receiver, they were, in effect, a signal on whatever wave length the receiver was tuned to. The signal was amplitude-modulated; so was the static. So when Armstrong got around to it, and developments in short-wave tranamission had got around to him, he devised a method of modulation which did not exist in nature. Instead of varying the amplitude or power of the carrier for signaling, the frequency being held constant, he held the amplitude constant and varied the frequency. That eliminated static automatically. A normal FM receiver therefore has a quiet field under conditions which would produce intolerable interference with an AM signal. And since FM stations need a wide band and can operate only on high frequencies, the waves will not, presumably, travel beyond the optical horizon. Thus there will be no crosstalk among distant stations, no matter how many of them there are.

All FM has to do after the war is to pick up where it left off. It has continued to operate; the war merely stopped its expansion for the time being. The Federal Communications Commission has already set up complete standards covering its operation. An estimated 500,000 FM or combination FM-AM receivers have been sold. Now FM is being used extensively by the armed services. It looks as if it is in for a sustained boom as soon as the labor and materials are available. According to one survey, 144 AM stations plan to file applications for FM transmitters at the end of the war, and that is only a beginning. One authority expects

(Continued on page 236)

...COUNT ON DEPENDABLE

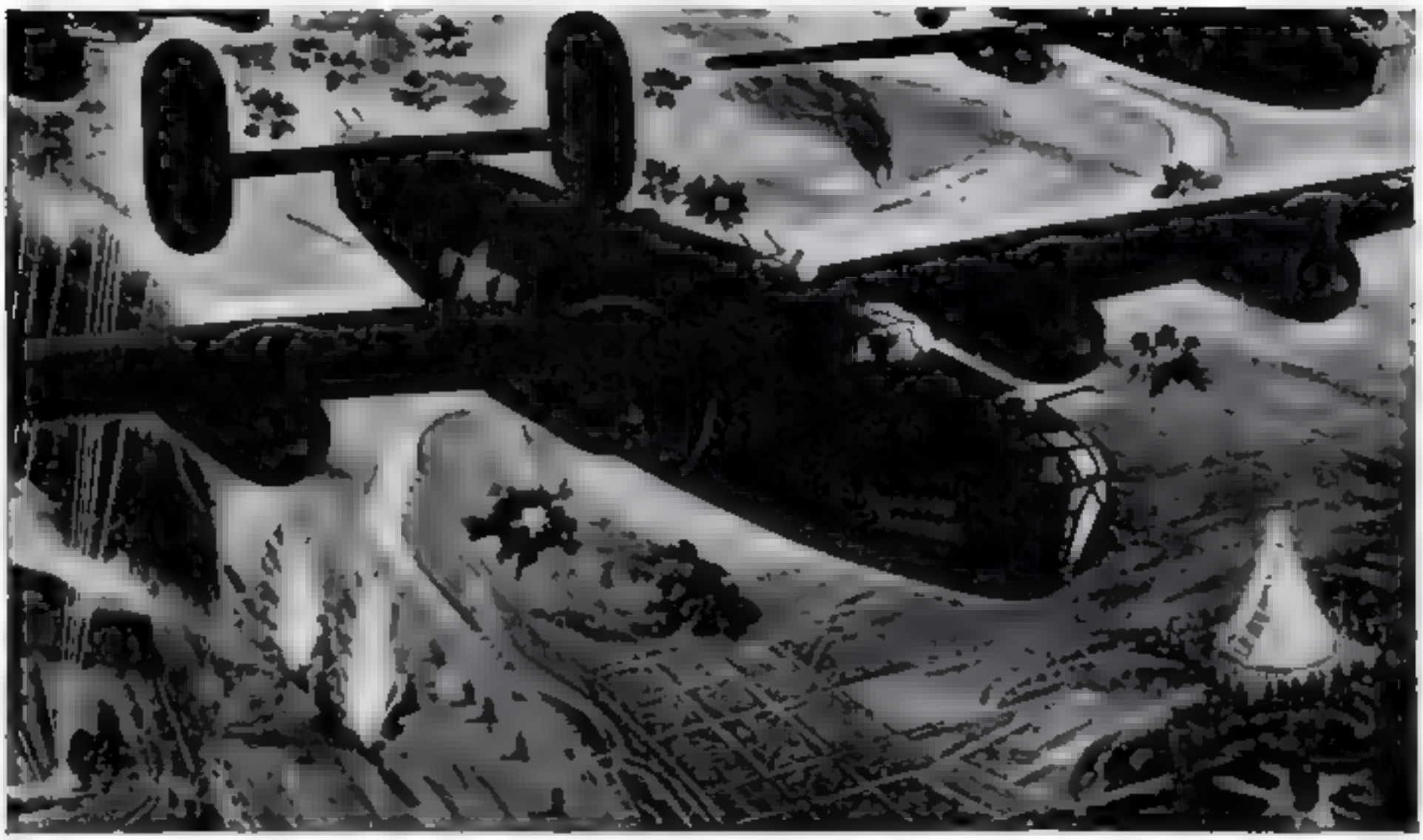
CHAMPION SPARK PLUGS

The American people will always give an overwhelming vote of confidence to that which they *know* they can depend upon. That's why more motorists prefer Champions to any other spark plug—why more Champions are in daily use, than any other.

The Champion Spark Plugs in service with our armed forces in the air, on land and sea and on the home front are piling up increasing evidence that Champion dependability really means something and is something you can count upon.

TO SAVE GASOLINE
—KEEP SPARK PLUGS CLEAN

LET'S ALL BACK THE ATTACK—BUY WAR BONDS



The "Rambler" Roars into Rangoon

This morning you're flying with the crew of the famous "Rangoon Rambler" . . .

Crouched in the glassed-in nose beside you, Lt. Guy Sports, the navigator, studies a map spread across his knees, checks off landmarks as they slide past underneath. Suddenly he peers ahead . . . speaks into his throat-microphone: "Pilot from navigator. There she is, Rote. We can see the target now. Alter course to three-three-zero."

"Roger!" Capt. Raymond Rote, the pilot, eases the big B-24 around and straightens out on his new course.

Then you see it . . . a splash of flame against the green horizon . . . the great, gold-domed Shwe Dagón Pagoda that towers over Rangoon. You're getting close . . . and the crew gets set. Lt. Robert Currie, the bombardier, fiddles with the knobs on his bombsight. Capt. Gordon Wilson, co-pilot, gives the instruments a last-minute check.

Now you're over the target . . . a flock of pot-bellied Jap cargo ships squatting there in the river's bend. The "Rambler" lurches and bucks as she ducks through bursts of ack-ack and goes into her bombing run.

Your heart pounds hard. Then Currie comes in on the intercom . . . cool as if he were ordering cokes at the Assam Officers Club: "Pilot from bombardier. Bombs away! Let's get out of here, pal!"

Looking back and below, you watch the formation's bombs bullseye the target. A freighter goes up in a blast of fire and black smoke. The ship beside it explodes. Flames break out from a third. And a fourth. Currie and the other bombardiers were "on the beam" today.

Rote banks the Lib around steep, and you high-tail for home. You're congratulating yourself when . . . "Fighters at four o'clock—high!" somebody yells. You look up and see a formation of Japs sweeping out of the sun.

Now it's the gunners' turn. And between squirts of their big, twin-50's they keep up a running pep-talk:

"There goes his wing down! He's coming in! This one's *my* meat, Salley!"

"Hey, skipper—kick her over a little. I want a good shot at this guy."

And two Japs spiral down in flames, and the rest decide to quit. That's all for today. You look around at the crew, relaxing now, shooting the breeze, adding up the score. You think of the ribbons each man has won for flights like this.

And it makes your chest puff out with pride to be flying with guys like these . . . to be wearing the wings of the AAF—the "greatest team in the world!"

U. S. ARMY RECRUITING SERVICE

THE 'RANGOON RAMBLERS'', Standing: Sgt. Ferdinand Knechtel, gunner; Capt. Raymond Rote; Capt. Gordon Wilson, Lt. Guy Sports; Lt. Robert Currie; Sgt. Joseph Wills, gunner. Seated: Sgt. John Craigie, Sgt. Carl Tuia, Sgt. Adolph Soolavian, Sgt. Edward Salley, gunners.

MEN OF 17 . . .

If you want to fly on the "greatest team in the world," an AAF air combat crew . . . go to your nearest AAF Examining Board . . . see if you can qualify for the Air Corps Enlisted Reserve. If you qualify, you will receive this insignia . . . but will not be called for training until you are 18 or over.

When called, you will be given further tests to determine the type of training you will receive. If you are trained as a gunner or technician gunner, you will go into actual combat as a non-commissioned officer. If your aptitudes are outstandingly high, you may be trained as a bombardier, navigator or pilot, and graduate from training as a Flight Officer or Second Lieutenant.

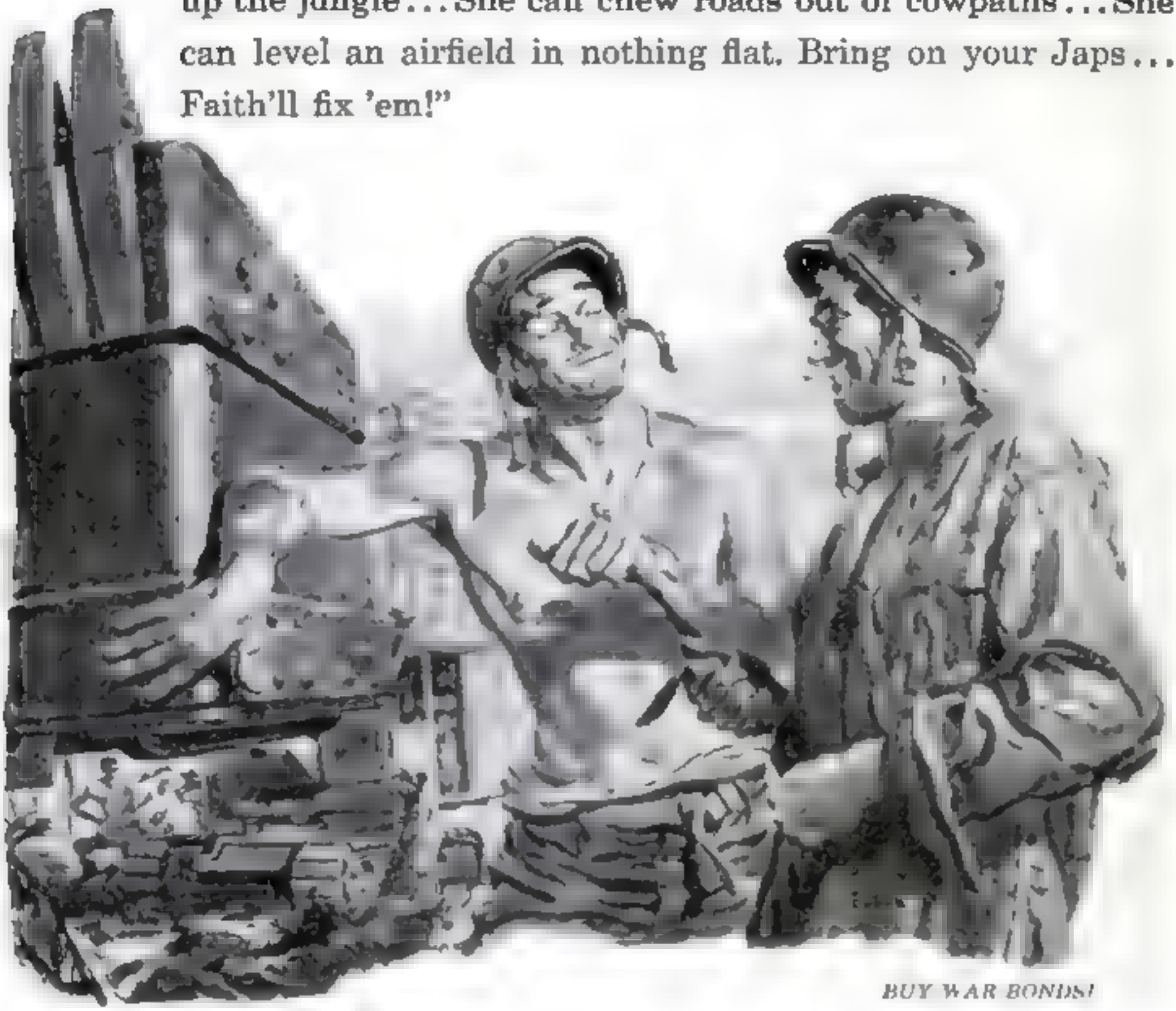
But *whatever* your job on an AAF air combat crew you will be the best-trained flier in any army on earth.

For pre-aviation training, see your local Civil Air Patrol officers. Also see your High School principal or adviser about recommended courses in the Air Service Division of the High School Victory Corps. Ask about the opportunities for college training through the Army Specialized Training Reserve Program.

For information on Naval Aviation Cadet Training, apply at nearest Office of Naval Officer Procurement. This advertisement has the approval of the Joint Army Navy Personnel Board.

FLY AND FIGHT WITH THE AAF GREATEST TEAM IN THE WORLD

"I CALL HER 'FAITH'...ON ACCOUNT OF SHE CAN MOVE MOUNTAINS! This power shovel of mine just eats up the jungle...She can chew roads out of cowpaths...She can level an airfield in nothing flat. Bring on your Japs... Faith'll fix 'em!"



BUY WAR BONDS!

"Faith" gets her muscle from a mighty Chrysler Industrial engine. Like the engine in Chrysler cars, it's Superfinished... which means it has the smoothest moving parts in the world... which means greater durability, fewer repairs for the power shovel... which means speeding the road to Tokio, the road to Victory!

WAR PRODUCTS OF CHRYSLER DIVISION

Industrial Engines • Marine Engines • Marine Tractors • Navy Pontoons • Harbor Tugs • Anti-Aircraft Cannon Parts • Tank Engine Assemblies • Tank Parts • Airplane Wing Panels • Fire-Fighting Equipment • Air Raid Sirens • Gun Boxes • Searchlight Reflectors

CHRYSLER

DIVISION OF CHRYSLER CORPORATION

THE NATION-WIDE CHRYSLER DEALER ORGANIZATION OFFERS OWNERS SERVICE FACILITIES TO MEET THEIR TRANSPORTATION NEEDS

Postwar Television

(Continued from page 232)

2,000 FM stations within a 10-year period. Another speculates on an immediate postwar market for 12,500,000 home FM receivers, and believes FM automobile receivers will come into general use. The trend is toward frequency modulation right down the line.

This does not mean that amplitude modulation is through. For one thing, you can't throw out 900 AM broadcast transmitters and 60,000,000 receivers with a mere twist of the wrist. For another, FM is essentially an urban service, with transmitters in the centers of cities and its aerials perched on high buildings. The countryside will still have to be served largely by powerful AM stations on the medium waves.

The transition from AM to FM is likely to proceed through the addition of FM transmitters to existing standard-band AM transmitters, as well as the erection of independent FM transmitters. Most listeners will be equipped with combination AM-FM receivers. Once it is indicated that the great majority of the listeners in a particular service area are relying on FM transmission, the older method can be discarded.

Many other improvements in broadcast reception may be expected after the war. Portable receivers, already reduced to camera size, are likely to assume the proportions of a cigarette case or wallet. This may seem fanciful, but all that is required is a further reduction in size proportional to that which occurred between the two world wars, not only in portable radios, but in flashlights, hearing aids, and the like.

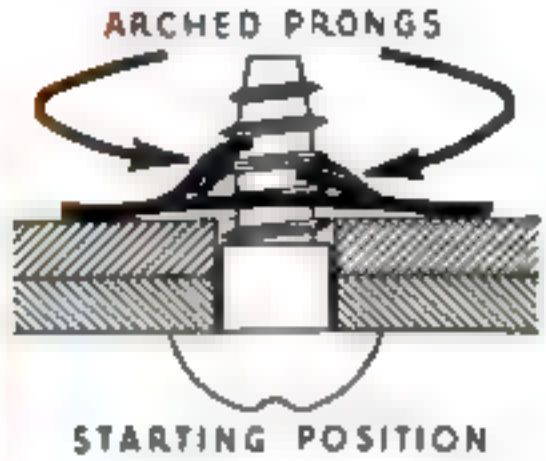
The postwar home radio receiver is likely to incorporate television, FM and AM sound reception, and a phonograph with a recording adjunct. A 16-mm. movie projector may also be incorporated but that likewise is no early prospect. All sorts of possibilities, such as recording of television programs on film in the home, can be envisioned for the more remote future, without much likelihood of attaining importance within the 10-year postwar period. But, even limited to the primary services of sound and picture reception and sound reproduction from records, the radio cabinet will be the electronic theater of the home, filling the major part of the average American family's entertainment needs, and exerting an immense influence on its mode of living and thinking.

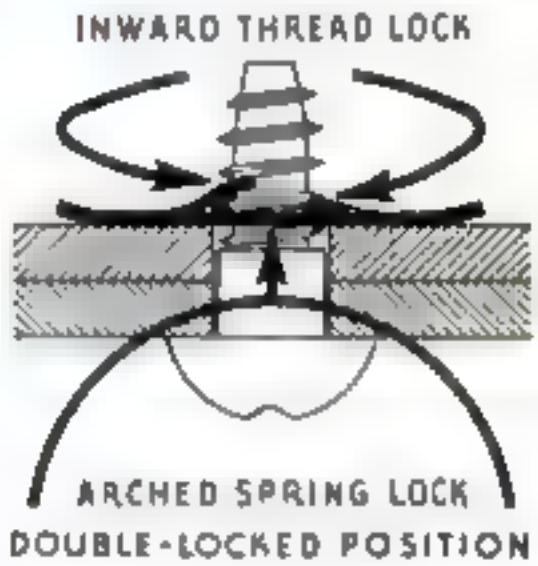
In the third of this series of articles, to be published in the September issue, Carl Dreher will discuss the miracles to be wrought by electronics in industry.

Look at the Speed Nuts [PATENTED]

SPRING-TENSION LOCKING ACTION!

FASTEST THING IN FASTENINGS!





An arched spring lock and an inward thread lock are basic features found only in Speed Nuts The ingenious design that sets up these two forces accomplishes more than you d realize unless you checked into it more closely.

Spring steel Speed Nuts have a base which is well arched, and arched prongs that are formed to follow the helical pitch of standard screw threads. As the screw is tightened, the arch is reduced, forcing the prongs deeper into the root of the screw threads. This provides a double spring-tension lock that prevents vibration loosening.

Speed Nuts eliminate the use of lock washers and are 50% to 75% lighter in weight than other self-locking nuts. They are faster to apply, and drastically reduce assembly costs. Double your use of Speed Nuts and you will double your assembly savings. Write for literature.

TINNERMAN PRODUCTS, INC.
2022 FULTON ROAD • CLEVELAND 13, OHIO

In Canada . . . Wallace Barnes Co., Ltd., Hamilton, Ontario
In England . . . Simmonds Aerocessories, Ltd., London

The lightest weight self-locking nuts ever produced!

There's been a big change

THE GAME is the same—but look at the clothes! The principle of the tapered roller bearing hasn't changed, either—but Tyson has developed an *All-Rolls* design which has vastly improved bearing efficiency.

When Tyson found a way to add *thirty percent more rollers* around the raceway, they set a new pace for bearing strength and rigidity. They increased load capacity. In many cases, they *doubled* bearing life.

The big name in bearings today is . . . **TYSON!**

TYSON BEARING CORPORATION • MASSILLON, OHIO

★ KEEP ON BUYING WAR BONDS ★

Buy War Savings Bonds and Stamps regularly.

knockout specialist

from stratosphere to sea level

Having won a reputation as master of the stratosphere, the Republic P-47 Thunderbolt now demonstrates its power as a low-level fighter-bomber in clearing the way for invasion. After attacking without warning at tree-top levels, the Thunderbolt speedily heads skyward at a new, faster rate of climb—aided by new wider Curtiss Hollow Steel blades.

CURTISS ELECTRIC PROPELLERS

Curtiss-Wright Corporation, Propeller Division

Postwar Battle Strength

(Continued from page 71)

followed by periodic "refresher" courses during summers. The program could be enacted into law at any time, with the provision that it would take effect at the cessation of the war, or upon proclamation by the President.

Upon the extent of this vast reserve of manpower, the size of our standing Army would largely depend. It could be held to a minimum, with consequent economy, if universal military training provided for its immediate expansion in time of emergency Nevertheless, it would probably be the largest army in our peacetime history. By way of comparison, the peak of Army strength in a year when America was not at war was about 800,000, near the end of 1940. In mid-1941, a few months before Pearl Harbor, growing war tension boosted its strength to more than 1,500,000. For our future permanent Army, a figure at least as large has been unofficially recommended.

Our Navy of the future will be shaped to fit an entirely new strategic concept of mobility. Until recently, it has been a fundamental doctrine that a fleet's strength falls off sharply as it ventures far from its main bases, to which battle-damaged craft must return for repair in big dry docks Hence, observers must have been puzzled by the operations in Far Eastern waters of some of our newest and finest battleships including the *North Carolina*, the *Washington*, and the *South Dakota*—and a number of our older capital ships. Much as a clash with the Japanese battle fleet might be welcomed, it seemed risky to venture so far from our home bases and so near to those of Japan with anything less than our whole naval might.

Now the Navy reveals how it unleashes its men-of-war to fight far from home with undiminished power. Giant floating dry docks, big enough to take a battleship, travel with the fleet. Any island harbor suitable for a fleet anchorage automatically becomes a first-class naval base. Towed separately to the scene of operations, the seven sections of the largest type fit smoothly together to accommodate a capital ship or an aircraft carrier, according to Rear Admiral Edward L. Cochrane, Chief of Bureau of Ships. Smaller docks of one-piece design serve for cruisers. Significant as a sidelight is the fact that the island which serves as an advance base need have no land defense works. During its temporary use, the guns of the fleet provide sufficient fortification.

(Continued on page 244)

TOUGH . . . but oh so gentle

Little engine troubles soon become big, expensive problems, if neglected. And one of the most common causes of engine trouble is worn-out piston rings.

Whenever *your* engine shows signs of ring failure—oil-pumping, smoke and loss of power—go to your motor service man. He will show you how to save oil, check cylinder wear and step up engine performance—with Hastings Steel-Vent piston rings.

HASTINGS MANUFACTURING COMPANY, HASTINGS, MICH.
Hastings Mfg. of Canada, Ltd., Toronto

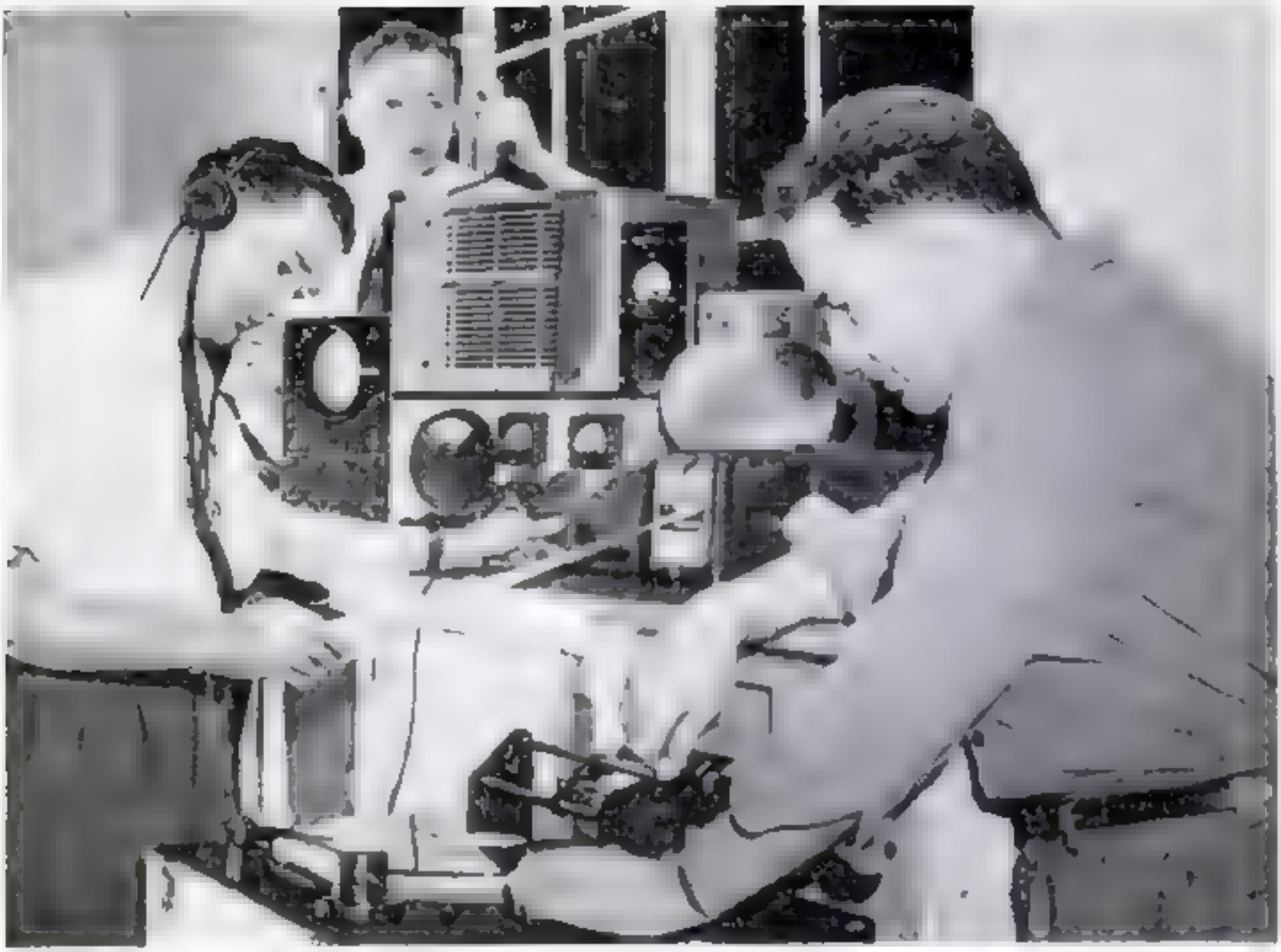
★

IT'S A PRIVILEGE
TO BUY WAR BONDS

★

HASTINGS STEEL-VENT
PISTON RINGS

TOUGH on OIL-PUMPING GENTLE on CYLINDER WALLS



WITH THIS APPARATUS, Consolidated Vultee Test Engineers on the ground can direct a test pilot in flight maneuvers and read the results of the maneuvers *even before the pilot knows them himself!*

Soap opera? No, test flight!

1924—Will it fly?

1934—How will it fly?

1944—Will it fly the way we said it would?

TO ANSWER that last question, Consolidated Vultee Aircraft Corporation maintains one of the most elaborate Flight Research Departments in existence.

Today's test crews are *provers*, rather than discoverers. The engineers tell them what the Liberators *should* do—and then the test men go upstairs to prove it *does*.

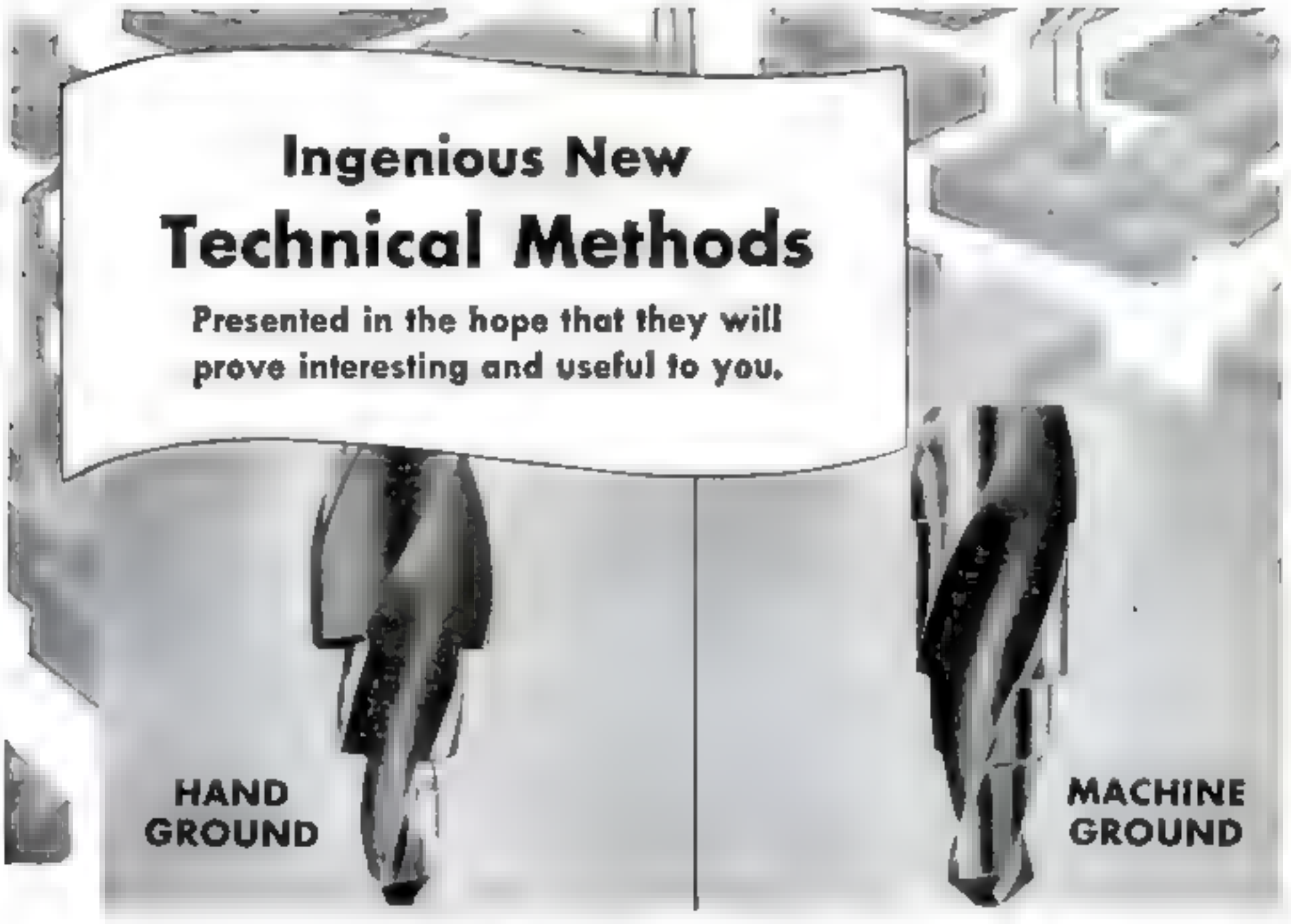
To speed and simplify their investigations (which cost around $400 an hour) Consolidated Vultee has perfected many devices and techniques now used by the entire industry. One incredible device (above) flashes a continuous stream of test data to a radio receiver on the ground.

The ground receiver instantly records on paper tape, sound film, and wax discs the readings of every instrument and gauge on the test plane.

Should trouble develop, the ground men can actually warn the pilot before he is aware of its existence!

CONSOLIDATED VULTEE AIRCRAFT

LIBERATOR	4-engine bomber	CATALINA	patrol bomber	VALIANT	basic trainer
CORONADO	patrol bomber	LIBERATOR EXPRESS	transport	VENGEANCE	dive bomber
SENTINEL	"Flying Jeep"	RELIANT	navigational trainer		



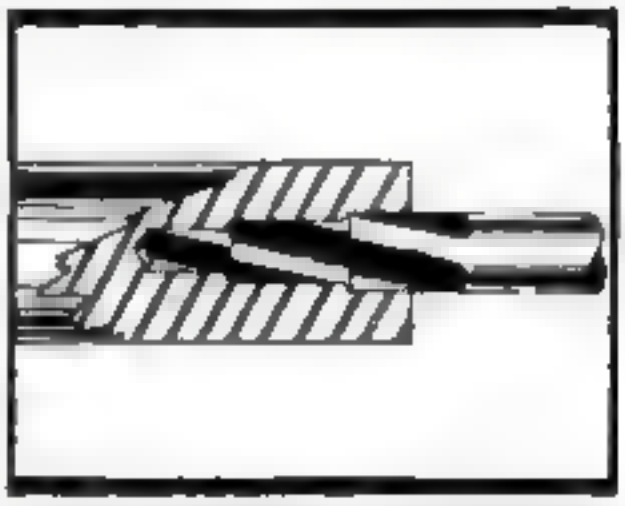
New Precision Step Drill Grinder Simplifies Production and Maintenance of Step Drills

The quality of a step drill produced by common methods depends almost entirely on the skill and attention of the individual tool maker. However, with the development of the precision step drill grinder, the human element has been entirely eliminated, the characteristics of the step being completely controlled by the grinding machine without adjustments during the course of grinding. This automatic feature insures absolute uniformity, regardless of quantity, and permits large-volume production of step drills.

The apparent advantages gained through the use of the step drill grinder are: Permits mass production of drills ground to exact specifications, entirely independent of the human element. Maintenance, too, is no longer an obstacle as step drills produced by this method are quickly sharpened by the same uniform machine-controlled operation. With the step drill grinder step drills can now be made from standard drills. These advantages result in a wider application of step drills which provide a definite saving of machine tools, man-hours and cost; this in turn results in greater production.

You know there are plenty of benefits in chewing gum, too. That's why all of the Wrigley's Spearmint we're able to make from our available stocks is going overseas to our fighting men and women. You know what a lift it's been on the job and we wish we could supply everybody, because we have pride, too, in our workmanship and productivity. But there just aren't enough available top quality raw materials right now to do it. When we can produce it in sufficient quantity, it will be back to you with the same fine flavor and chewing satisfaction . . . Wrigley's Spearmint has never been changed!

You can get complete information from Spiral Mfg. Corp., 3022 North Kedzie Avenue, Chicago 25, Illinois.



The above illustration shows mechanical design which requires a hole having diameters diminishing in steps. This is an operation for step drills which has often been neglected due to difficulty in obtaining and maintaining step drills.

Step drills produced by our method are quickly sharpened by the same uniform, machine-controlled method.

Y-128

Postwar Battle Strength

(Continued from page 240)

Thus the spotlight falls upon the Japanese-mandated clusters of islands in the Carolines and the Marianas, and the Japanese-invaded islands of the British-owned groups. "Destruction of the Japanese Empire" must pave the way for victory in the Pacific, declares Admiral Ernest J. King, Commander in Chief of the United States Fleet and Chief of Naval Operations. What else can that mean, among other things, than stripping Japan of Pacific islands she never owned? Certainly the ones we have wrested from her with American sweat and blood will not be handed back. That we seek no territorial aggrandizement, as made plain in the Atlantic Charter, does not conflict with acquisition of bases essential to our national security. As the expression is heard in Washington, it would not be surprising if we picked up some real estate. As for such cases as our ejection of the Japs from Tarawa, a British possession, there have been delicate hints to the effect that Great Britain might not object to our permanent occupancy, in the course of a general postwar settlement.

One realistic fact stands apart from diplomatic finesse and hopeful dreams of international organization. The United States will emerge from this war with the greatest navy in the world. Britain's should be a good second. What could be more natural, therefore, than to co-operate in policing the seas? No formal treaty would be necessary. An armchair strategist might envision a mutual agreement under which the United States Navy would patrol the western half of the Atlantic, and the whole Pacific, except for the waters bordering British dominions. Britain, on her part, might assume control of the eastern Atlantic, the Mediterranean, and the Indian Ocean

In the potential trouble spot of the Southwest Atlantic, we would do well to seek the participation of friendly South American powers. The modest size of their navies could be materially augmented by transferring to them some of the smaller surplus warships from our peacetime Navy, as recently recommended by a House naval subcommittee headed by Representative F. Edward Herbert, of Louisiana.

Joint maneuvers, with exchange of high command, would foster good will and perfect plans for hemisphere and world control of the seas.

People who believe in a big navy, a recent survey indicates, are backed by an im-

(Continued on page 248)

A Camera Fan is MADE...not born!

Johnny got his start at age 13, with a *Universal*. For even then Universal was ahead of the field, by providing a candid camera at a price so low that millions of little Johnnies could afford to buy it.

Among Johnny's first pictures are this and the one at left, of the kids next door. They're certainly no prize winners . . . but Johnny, like most beginners, didn't know so much about composition in those days.

When Johnny entered high school, Dad gave him a better *Universal*. He joined the school camera club and started reading hobby magazines like this one. Some of his photos even made the school year book.

College meant new camera thrills to John, with his *Universal Mercury*. Universal was again ahead of the field with a camera that could stop action faster than any other candid camera available before the war.

John's not taking many pictures now. But you should have seen his eyes light up when he spotted Universal's name on his Navy *Binoculars!* Universal's at war, too, making fine military optical instruments!

The war will end...

And thousands of Johnnies will come home. Then, fans like John, and others who aren't fans yet, can look forward to a whole new series of great Universal cameras and photographic equipment. For Universal is still pioneering . . . this time in methods of large scale precision production of military optical instruments. Count on Universal to utilize these achievements in its postwar camera program. *Expect your next camera to be a Universal*

Remember: One picture from home is worth a thousand words to a Serviceman

UNIVERSAL CAMERA CORP.

NEW YORK • CHICAGO • HOLLYWOOD

Peacetime Manufacturers of Mercury, Cinémaster, Corsair Cameras and Photographic Equipment

STRIKING POWER

More than 50,000 Allison engines have been built for the use of Allied fighting pilots around the globe. ★ These skilled pilots using fighting planes powered by these engines have established a lopsided "box score" in our favor. ★ That is testimony to the striking power of good men armed with good American fighting equipment. ★ It is also an indication of aircraft engine performance you will be glad to have in the planes you use after final victory.

POWERED BY ALLISON

P-38—Lightning
P-39—Airacobra
P-40—Warhawk
A-36 and P-51—Mustang

The more than 50,000 Allison engines built for the U. S. Army Air Forces power the above planes

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Allison

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Indianapolis, Indiana

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AGAIN, ZENITH MAKES HEARING AID HISTORY!

Brings New Smartness and Style at No Extra Cost with the

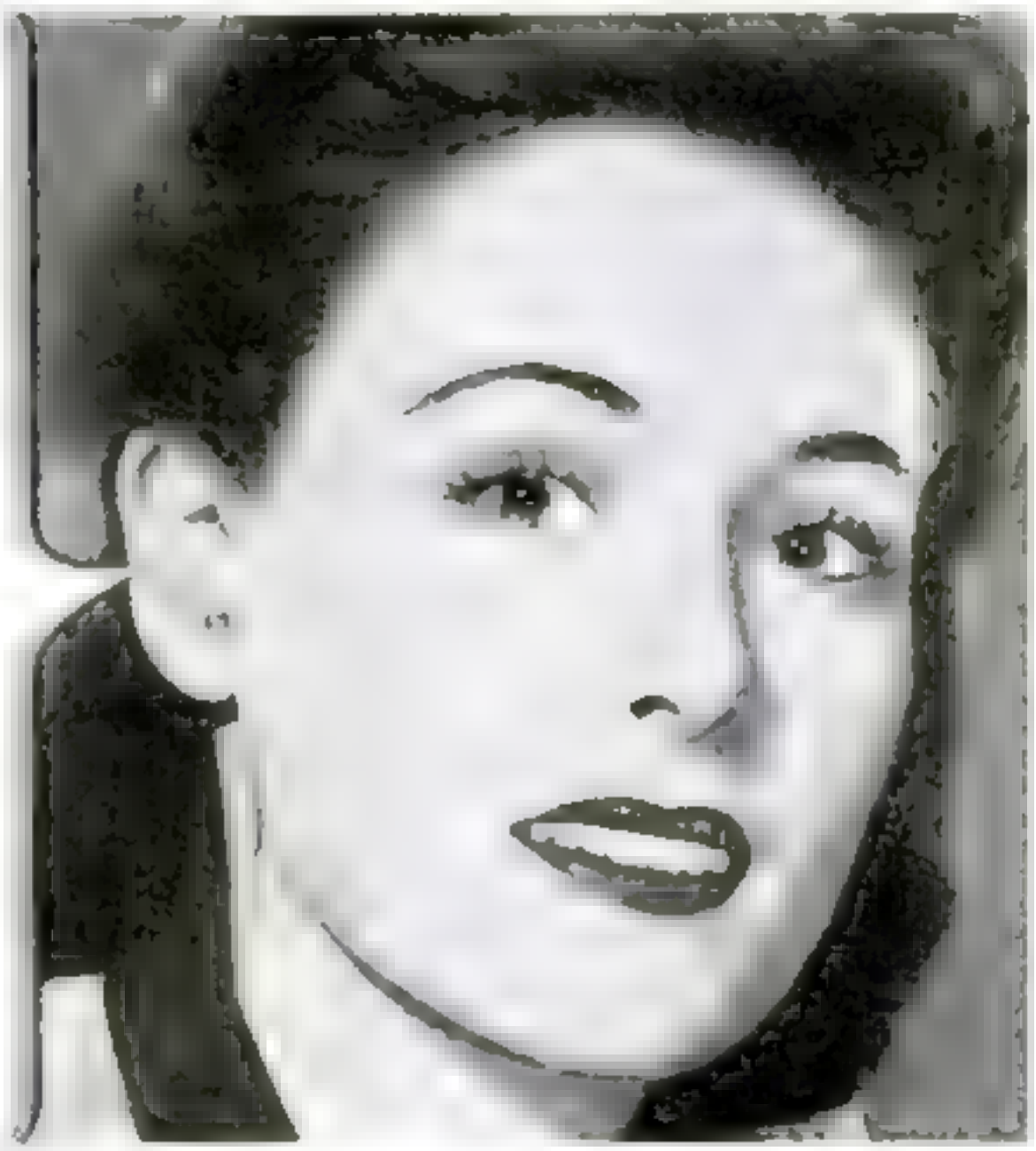
New Neutral-Color Earphone and Cord

ZENITH made hearing aid history by bring ing fine precision *quality* within reach of all. Now Zenith follows through—makes history again—brings you, in its complete production, an entirely new standard of hearing aid *smartness and style!*

After years of research—Zenith now does for the hearing aid what modern styling did for eyeglasses! Now America's hard of hearing can wear an aid with visible parts that are *scarcely noticeable,* because they blend with any complexion.

This smart new Zenith ensemble brings an attractive new "look of youth" to the hearing aid. You'll notice it immediately when you look at yourself in the mirror. Now, no one need feel self-conscious about wearing a hearing aid.

See the proof of this today. And *hear* the proof of excellence in performance that has made America swing *overwhelmingly* to the New Zenith Radionic Hearing Aid. Visit the Zenith-franchised dispenser nearest you. Or, for complete information by mail, use the convenient coupon below



THE NEW ZENITH RADIONIC HEARING AID

THE NEW EARPHONE

- Smart, modern, scarcely noticeable, pleasingly neutral in color so that it blends with any complexion.
- Sturdily constructed of beautiful long-wearing plastic
- Comfortable to wear because it's feather-light in weight.

THE NEW CORD

- Translucent plastic . . looks well with any apparel. Greatly reduces friction or clothing noise.
- Slender, light in weight, more comfortable, lasts longer
- Perspiration-proof . . . water-proof . . . kink-proof . . . washable . . . will not fray. wipes clean with damp cloth.

Accepted by American Medical Association Council on Physical Therapy

★

$40 COMPLETE, READY TO WEAR
With New Neutral Color Earphone and Cord — Crystal Microphone — Radionic Tubes — Batteries — One Quality, Zenith's Best

BY THE MAKERS OF

ZENITH RADIO

RADIONIC PRODUCTS EXCLUSIVELY—
WORLD'S LEADING MANUFACTURER

GOOD NEWS FOR CANADIANS

The New Zenith Radionic Hearing Aid is now available in Canada—*direct by mail only*—at $40 complete (Canadian currency) with no additional charge for transportation, duties or taxes. For particulars write our Canadian distributor, Dept. PS 7, Zenith Radio Corporation of Canada, Ltd., Guaranty Trust Bldg., Windsor, Ont.

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P. O. Box 6940A, Chicago 1, Illinois

Please send me your Free descriptive booklet on the New Zenith Radionic Hearing Aid.

Name _____

Address _____

City _____ *State* _____

☐ Physicians check here for literature.

ZENITH RADIO CORPORATION, CHICAGO, ILLINOIS

Postwar Battle Strength

(Continued from page 244)

pressive number of United States Senators. They will be relieved to know that we do not contemplate scrapping any of the big fellows—our battleships and large aircraft carriers, now afloat or building—under any postwar plan. (Shipbuilding miracles since Pearl Harbor have shortened the time it takes to build a battleship from 39 to 32 months, according to Admiral King, but the time is still far too long for a country facing a sudden emergency.) Likewise, our monster 45,000-ton aircraft carriers will go forward to completion. Plans for limited naval disarmament concern no warships larger than destroyers except, perhaps, for a few cruisers. And these will not be junked or sunk. Those kept in our possession will be laid up with the aid of the most modern preservatives, which can be applied with a spray gun to form a corrosion-resisting film. Moisture-absorbing chemicals such as silica gel or calcium chloride will help keep machinery from rusting. Thus protected from the elements, recent naval experiments upon the old catapult ship AVC-1 show, they can be readied at short notice to put to sea.

Powerful as our Navy will remain for years to come, it will be a forward-looking policy to build at least an experimental battleship, cruiser, and craft of other types from time to time. In this way, the latest ideas in naval design will have prompt trial, and plans will be ready for future use.

Aviation, in contrast with sea power, would be advanced rather than weakened by scrapping warplanes! No better example could be found of the number of interlocking factors concerned in keeping our Army and Navy air forces at top efficiency.

We might maintain more planes than the rest of the world combined, and still be inferior in air power to a nation possessing later models. Craft shot down or damaged beyond repair in combat, and others simply worn out in accelerated war service, together make up almost a negligible proportion of our true air losses. Old Man Obsolescence accounts for the rest. Many a perfectly good combat plane has been relegated from the battlefront to a training base, or junked for whatever parts can be salvaged, simply because it has been outdated by an improved enemy design. In the roar of wind tunnels and the hum of aircraft factories are born the machines that in months to come, will plague the Allies and the Axis.

Never before has there been such pressing

(Continued on page 250)

More power to all the G. I. Joes who brag about the wallopers they caught . . . and the still bigger ones they'll catch in happy days to come. The boys talk a heap of fishing, we're told. Maybe those big Evinrudes that serve with them help sharpen old fishing memories — and appetites!

One of those great Storm Boat Evinrudes would make at least a dozen fast, smooth, rugged fishing motors . . . the kind they'll want when they get back. And we'll do our darndest to please them!

FREE! Send for this special issue of the "Evinrude News" A pictorial magazine that covers outboards in war and peace — profusely illustrated with photos showing Evinrudes serving the Army and Navy, and pictures of happy peacetime uses to follow! Write today for your copy! EVINRUDE MOTORS, 5077 North 27th Street, Milwaukee 9, Wisconsin.

EVINRUDE

OUTBOARD MOTORS

★ EVERY DOLLAR YOU INVEST HELPS SPEED VICTORY . . . BUY MORE WAR BONDS

Postwar Battle Strength

(Continued from page 248)

need for research, Rear Admiral D. C. Ramsey, Chief of the Navy's Bureau of Aeronautics, tells the writer. Phenomenal developments of today and tomorrow—jet and rocket-propelled warplanes, and aircraft traveling faster than the speed of sound—demand that American aeronautical engineers keep us in the forefront of world progress, he declares. And they are doing it. Into a single airplane engine, to mention just one achievement, they have just succeeded in packing the unheard-of figure of nearly 3,000 horsepower. Such a power plant almost inevitably means new airplane types to take the fullest advantage of it.

Hand in hand with research goes the production capacity that translates engineers' blueprints into fleets of airplanes. So high does it rank in importance that military men judge a nation's air power not so much by the number of planes it has, but by the rate at which it can build them. Magnificent is the only word to describe the effort of airplane factory workers who have expanded America's output of aircraft between January, 1940, and March, 1944, by 3,400 percent in number of planes and by 6,800 percent in tonnage.

In postwar years we can safely get along with a fraction—perhaps one third—of our wartime air strength, always provided that we can rely upon rapid expansion of warplane output in an emergency. Expected strides in civil aviation should provide an abundant reserve of experienced airmen, and of some types of planes that can easily be converted for war service. Rip out the passenger seats of a commercial airliner, for example, and you have an excellent military cargo plane. But nothing in the world can be converted into a satisfactory bomber. Peacetime maintenance of our warplane fleets, and the capacity to expand them, should therefore include a steady flow of orders for strictly military types, to keep these factories humming. This would form a part of an orderly replacement program—amounting, say, to one fifth of our total number of planes yearly—to assure us of up-to-date air forces.

There, then, are the elements of a suggested plan for America's peacetime military establishment. Enthusiasts for one or another of the armed services—land, sea, or air—may feel that it deserves more special emphasis. But only the intimate teamwork of every service could effect the history-making Allied invasion of France, and great seaborne actions still to come.

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...after

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You're in clover in more ways than one with a MARFAK chassis lubrication job. Your car loses that old logy feeling, takes on velvety smoothness and new handling ease. And it's efficiently protected against wear by tough, long-lasting MARFAK that has been applied by *chart* not by chance. Every point of wear, every point of adjustment gets a going over . . . from control arms to rear shackles. Ask your Texaco Dealer to give your car that "MARFAK feeling" — now!

THE TEXAS COMPANY

Let us MARFAK your car

TEXACO

TUNE IN the TEXACO STAR THEATRE ever... Sunday night. See your local newspaper for time and station.

Five New U. S. Planes

(Continued from page 59)

itself has unusual details. For example, it has devices to handle 37 different types and sizes of bombs. It was found that if six feet were added to the original length of the bomb space not only could the original load of big fellows be carried, but the same weight could also be carried in small bombs.

The controls of the plane are so perfectly balanced that no booster motors are needed. In fact, the controls moved almost suspiciously easy when the writer tested them after a flight as the guest of Boeing at Wichita, Kans., a few weeks ago. They had about the same feel and touch as those of a Piper Cub in flight.

The giant dorsal fin gives amazing stability. Even though two engines on one side may quit during the take-off, the plane will not swerve dangerously. The leading edge of the stabilizer turns up in the manner of an inverted airfoil. This prevents stalling of the stabilizer at a critical flight attitude.

There are 129 different electric motors on each plane, plus 26 motor regenerators and seven generators. The last-named are capable of 57,000 watts rated output, with 50-percent step-up for limited pedods. The 129 motors range from tiny units of 1/100 horsepower up to some of six horsepower.

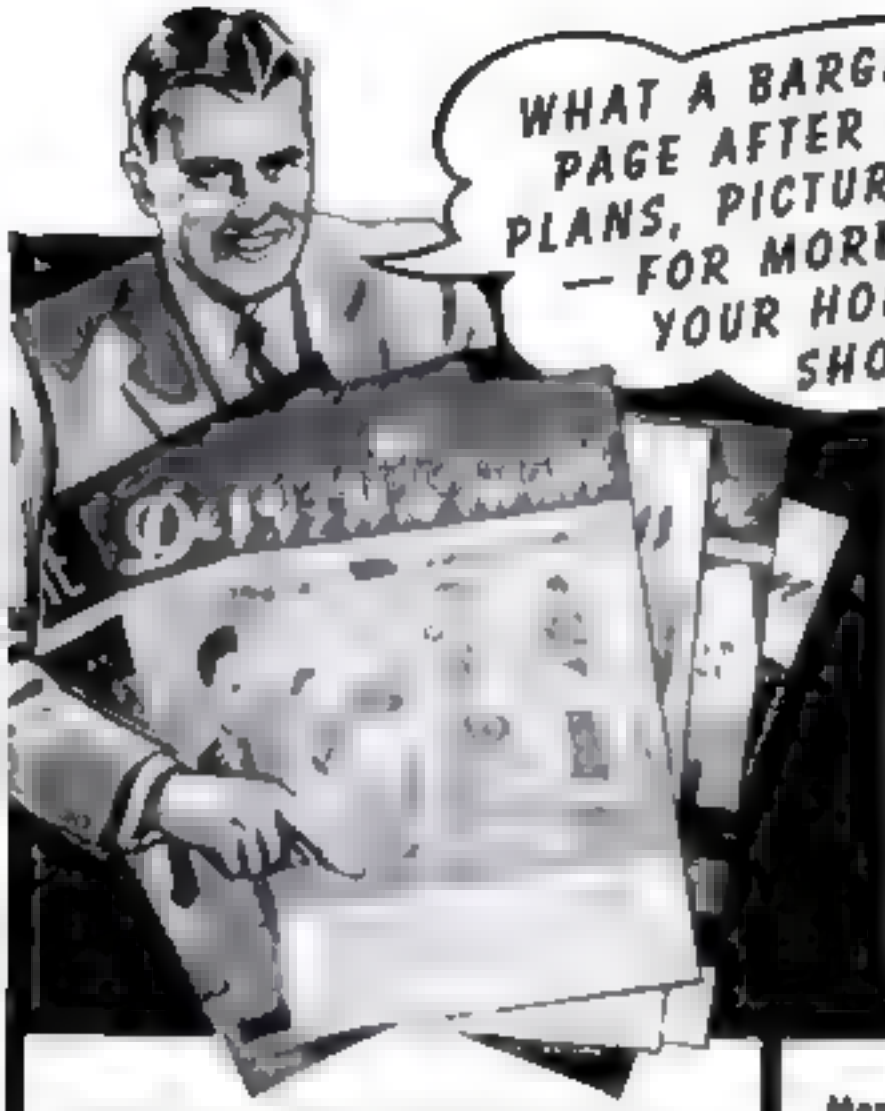
The main landing gear weighs 5,615 pounds, while the nose gear, with its double wheels, weighs 1,036 pounds—about the same as a loaded light plane. The main landing-gear tires contain 21 pounds of air at 75 pounds' pressure per square inch, while the nose-gear tires carry only three pounds of air at 50 pounds' pressure, or less than the tires of a bicycle. The fuselage contains about 5,000 cubic feet, or nearly twice the cubic content of an average railroad box car.

Nearly two tons of synthetic rubber are required to make the 30 bullet-sealing fuel tanks carried aboard the Superfortress. In all, there is close to 5,000 pounds of rubber in this plane, contained in over 200 different parts.

An unusual item carried into combat is a supply of "lipsticks" of a lubricating material used by the crew members to prevent doors from sticking.

Crews are carried in pressurized compartments in order that they may fly at extreme altitudes to and from their targets and arrive over the area in the best possible physical condition. The compartments are

(Continued on page 258)



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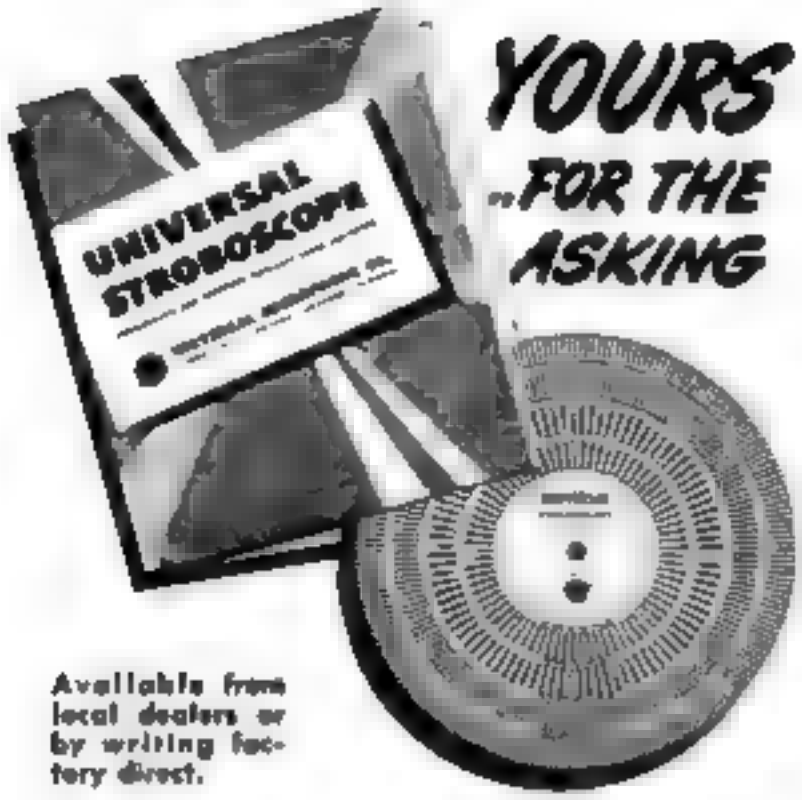

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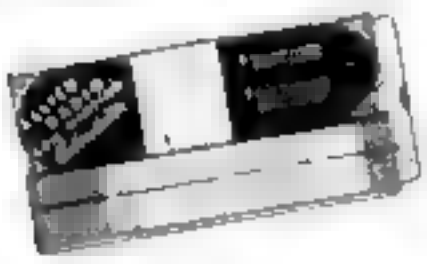

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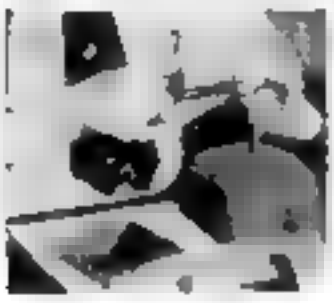

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Five New U. S. Planes

(Continued from page 254)

pressurized through use of part of the air fed to the engines by the dual superchargers on each engine nacelle. Boeing, who pioneered the pressurized Stratoliners before the war, have worked wonders with the B-29 to give the crew the best possible combat conditions through this pressurizing, which maintains comfortable conditions within, no matter what the altitude.

The compartments are deflated or depressurized when entering the bombing area, and the crew goes on oxygen. After the bombs have been dropped and the plane turned toward home, the pressure is again built up to a comfortable level. The depressurizing of the chambers is done instantly. It has been found through research and actual experiments that an instant deflation of a pressurized chamber results in less actual discomfort and harmful effect on the personnel than a gradual decompression. The reason for the decompression over the target area is that the crew cannot afford to have to a scramble around for oxygen bottles should the compartments become decompressed through enemy flak or gunfire during the critical bombing run.

Since the compartments can instantly be recompressed to the required pressure altitude after the bombs have been dropped, it is only for a matter of minutes that the crew works in the decompressed chambers. There is no physical reaction to this at all, and the crews have the added protection of individual oxygen supplies during the critical moments of the mission. Not only are there more than enough plug-in oxygen stations about the ship, but each crew member has his own "walk-around" oxygen bottle attached to his electrically heated altitude suit.

The story of the development of these pressurized cabins is a saga of engineering achievement. Many obstacles had to be overcome before they were finally perfected, but so successful are they in their latest form that Wellwood E. Beal, Boeing's vice president in charge of engineering, believes that all postwar commercial planes will be designed with pressurized cabins for the passengers.

The B-29 compartments have been subjected to every grueling test that the plane-wrecking testing department could dream up. They have undergone machine-gun fire, cannon fire, and simulated flak damage. They have been pressurized until they actually burst wide open.

(Continued on page 262)

THE HOW AND WHY OF WILLIAMS DROP-FORGED TOOLS

USE OF WILLIAMS' THREADING TOOL HOLDERS

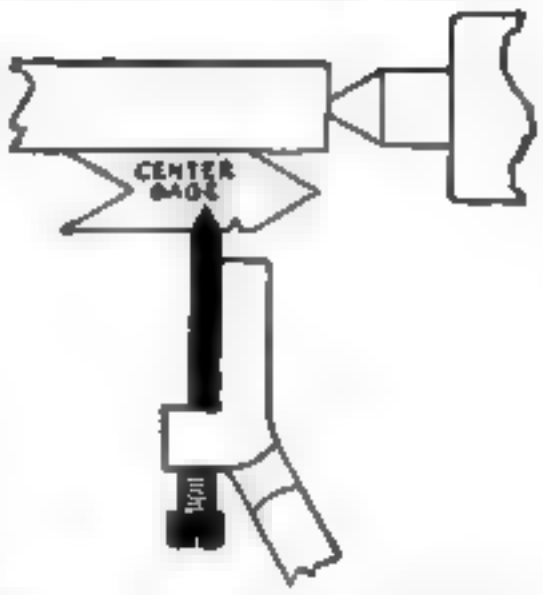
Thread cutting in the engine lathe is one of the most exacting lathe operations, and one which requires a thorough knowledge of change gear principles and procedure. However, the accuracy and quality of the final job depends upon the cutting tool itself. An explanation of the proper application of two types of Williams' Threading Tool Holders follows:

EXTERNAL THREADING WITH WILLIAMS' LOCKABLE SPRING-HEAD HOLDER

Made in 3 sizes for cutters 1/4", 5/16" and 3/8" square.

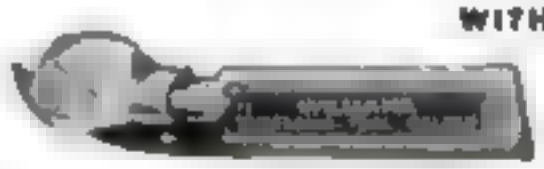
This tool is designed for both fine and coarse threading. Its Spring Head is equipped with a Locking Nut which provides the rigid backing required for heavy cuts; when loosened, the Holder becomes a Spring Tool for finishing work. Finished High Speed Steel cutters are furnished with this tool having each end ground to a "V" point forming an angle of 60°.

To set the Tool, first adjust the cutter so that only the ground portion projects beyond the holder. Now set the Holder in the Tool Post, adjusting the cutter point vertically to exact center of the work. Then place a Center Gage with its back edge in contact with the work, or the Tailstock Spindle, and adjust the Tool horizontally by fitting the cutter point *exactly* into the 60° angle notch in the front edge of the Center Gage. (see illustration). Tighten the Tool Post Screw, using caution not to change position of the Holder. Apply cutting oil to the work generously when threading steel.



Application of Threading Tool. Center Gage must be held parallel to the machine bed ways when setting tool.

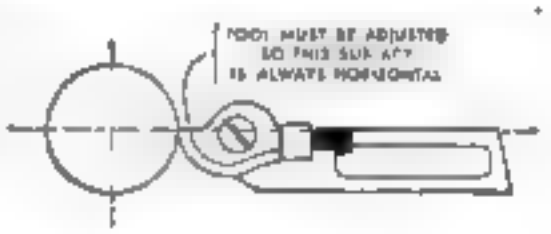
EXTERNAL THREADING WITH WILLIAMS' FORMED-CUTTER HOLDER



Made in 4 sizes, with formed cutters 5/16" to 5/8" thick.

The High Speed Steel Formed Cutter with which this tool is equipped is ground to an included angle of 60° and is backed off for correct clearance. In regrinding, the top edge only is ground, thus assuring a point of proper form and angle as originally supplied.

Procedure in setting this tool is the same as explained for the Spring Head Tool. In adjusting height of Tool so as to center on the work, do not use the Stop Screw on the side of Holder. This adjustment is used to compensate for metal removed from the cutting point in regrinding. The top surface of cutting point must always be horizontal when threading.(see illustration).



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Five New U. S. Planes

(Continued from page 258)

They found that the compartments under pressure will take many holes from machine-gun fire and even cannon shells without losing any appreciable amount of pressure, so efficient are the superchargers. To take care of any but the largest holes, pads have been designed to be applied while in flight. They are held against the inside of the hole by the internal pressure.

The designing of the clear plastic blisters to withstand the internal pressure was a major problem. Not only did they have to withstand the internal pressure, but the twisting of the opening due to flight stresses, the vibration of the plane, and the changes of temperature. On one flight over Texas at an altitude of over 30,000 feet, a crew member unfastened his safety belt to lean out into the blister to observe something on the outside of the plane. He leaned slightly against the transparent plastic dome. With a roar, the blister gave way, and out went the crew member. Fortunately he was wearing his parachute and had his "walk-around" oxygen bottle and mask. He landed, many minutes later, unhurt but considerably wiser. As a result of this incident, metal-rod "snoods" were fitted over the domes of plastic until a better and stronger fitting could be devised.

Many unexpected things developed as a result of the ability of the B-29 to fly and fight well over 40,000 feet. For example, it was found that many compounds and materials froze while others actually boiled and steamed at the high altitudes. To the amazement of all, sponge-rubber seat cushions swelled to enormous size, owing to the expansion of the millions of tiny bubbles in the material, and had to be redesigned. The plastic turret domes had to be redesigned because they steamed up at high altitudes. To overcome this, hot air was played over the inner surface, but then it was found that the great difference between outside and inside temperature caused the plastic to fracture. The entire composition and design of the domes had to be done over so that they not only would resist the changes in temperature and pressure, the vibrations of the plane, and the combat stresses, but also would remain as nearly optically perfect as possible.

The B-29 and the other hard-hitting members of the AAF's Varsity will see action on all fronts within the next few months, carrying the ball not only into the enemy team's end zone but right on into their locker room.—C. B. COLBY.

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But the great goal of the other Arms and Services is to bring the Infantryman to a position from which he may advance to hand-to-hand combat with the enemy.

Advancing across that last hundred yards of shell-torn field is the supreme test of battle. Generally it follows a nerve-wracking inching forward under enemy fire, under cover of the supporting fire of artillery, of the Air Forces, and of the heavy weapons of the regiment.

But as the Infantryman approaches the enemy lines, all this supporting fire must be lifted. He is "on his own." There is nothing in front of the front line of the Infantry except the enemy. Then the outcome rests entirely on the effectiveness of his own individual weapons —the rifle, the bayonet, the carbine, the hand grenade. And, most important of all, on the doughboy's courage and skill.

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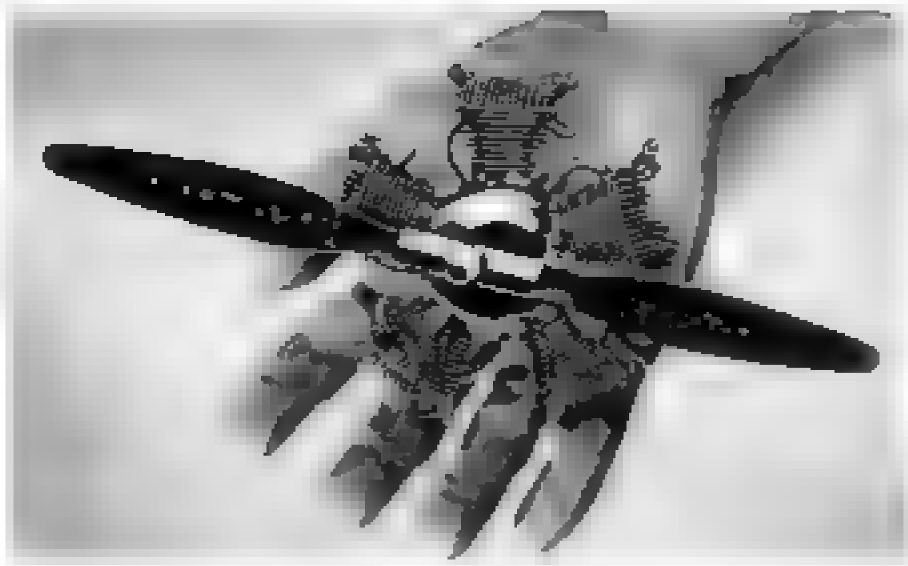

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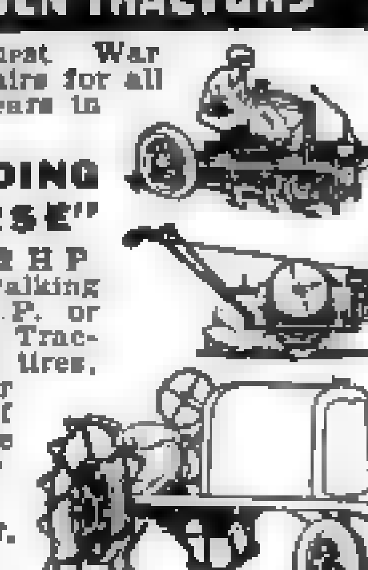

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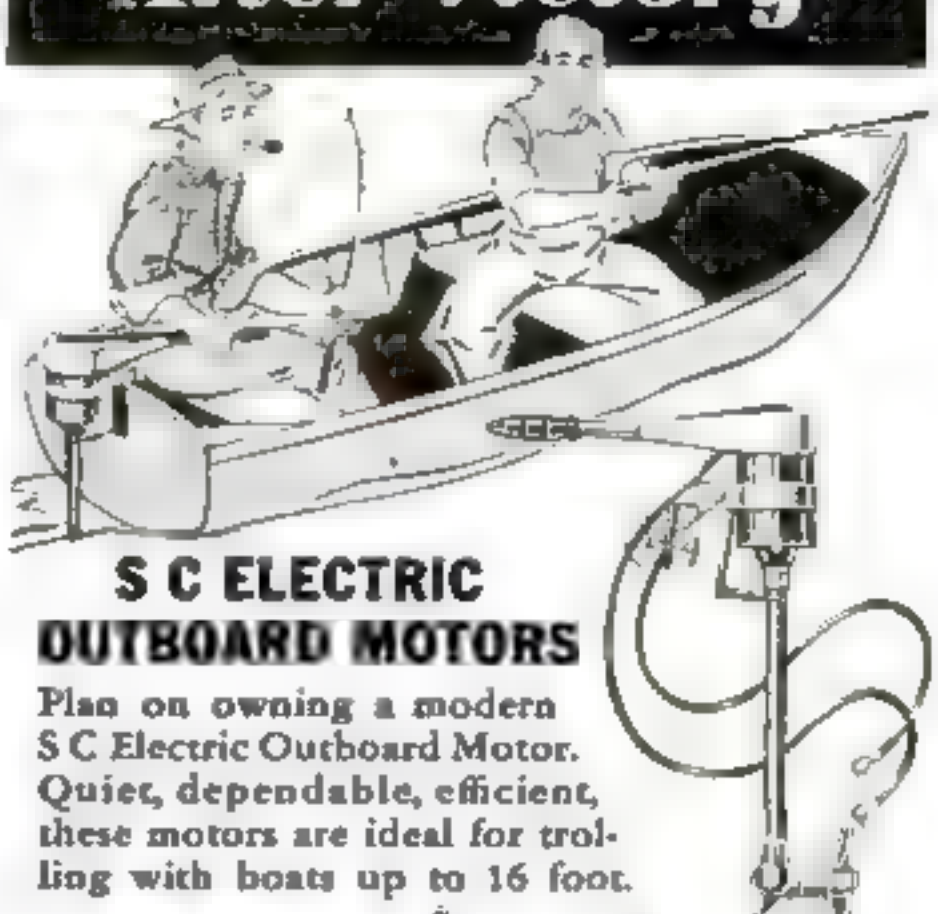

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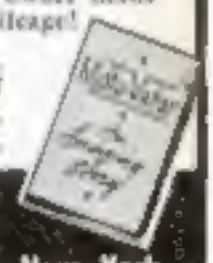

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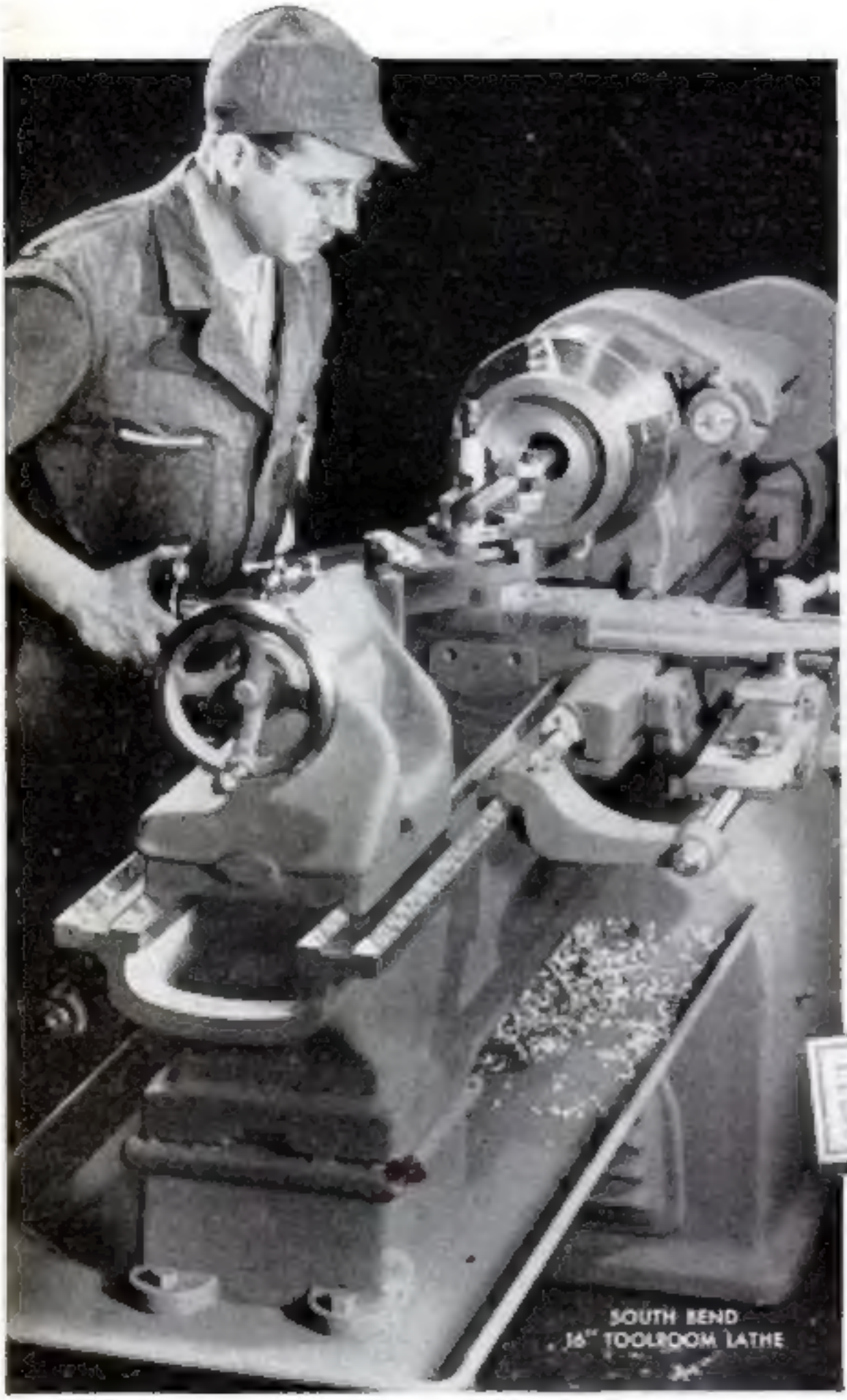

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